WORLD RESOURCES INSTITUTE

GUIDEBOOK

Water Quality Benefit Accounting

Guidance for implementing, evaluating, and claiming water quality benefits of water stewardship projects

LimnoTech

The Nature Conservancy

WRI.ORG

TABLE OF CONTENTS

AUTHORS

World Resources Institute: Sara Walker

LimnoTech: Derek Schlea, Steve Skripnik, Laura Weintraub

The Nature Conservancy: Naabia Ofosu-Amaah, Kari Vigerstol

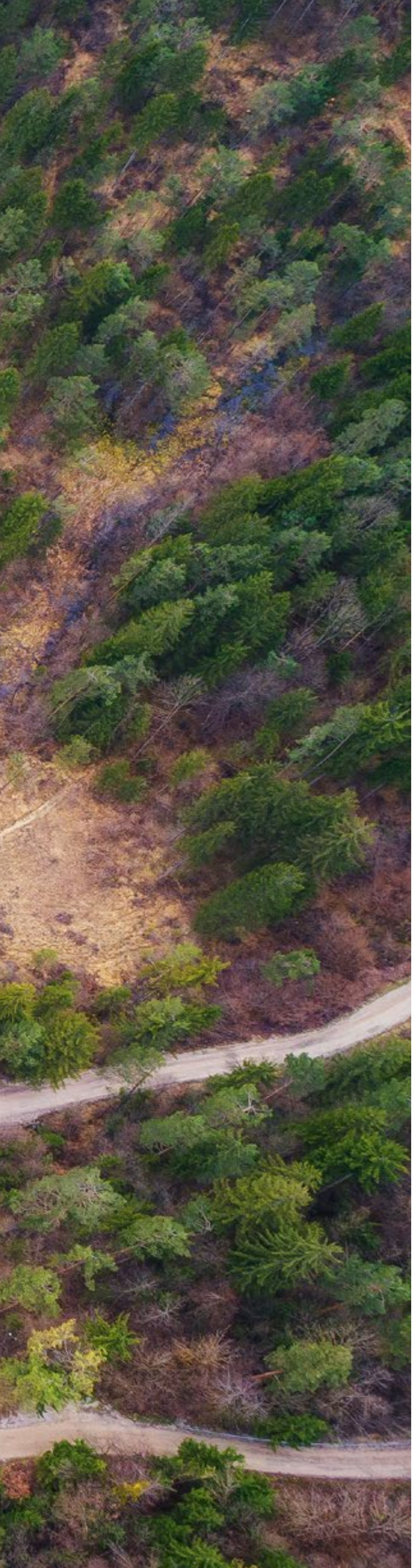
LAYOUT

Shannon Collins
shannon.collins@wri.org

VERSION 1 | SEPTEMBER 2025

Suggested Citation: World Resources Institute, LimnoTech, The Nature Conservancy. 2025. "Water Quality Benefit Accounting: Guidance for implementing, evaluating, and claiming water quality benefits of water stewardship projects." Guidebook. Washington, DC: World Resources Institute. Available online at: https://doi.org/10.46830/wrigb.23.00147.

Guidebooks are designed to help users apply a clearly defined standard, practice, or process.



EXECUTIVE
Summary

Corporate water stewardship has long focused on volumes, yet water quality concerns are rising on the public's and private sector's agenda. Volumetric Water Benefit Accounting (VWBA) has supported the private sector with valuing the volumetric water outputs of water stewardship activities, but comparable guidance has been lacking for water quality projects. Water Quality Benefit Accounting (WQBA) was developed to provide companies with voluntary and nonprescriptive guidance on selecting from a variety of water stewardship activities that address shared water challenges and determining the indicators and methods that are appropriate for quantifying, tracking, and communicating the activities' water quality benefits. Applicable to a variety of sectors and water pollutants, this guidebook provides corporate water stewardship practitioners and project implementers with clear steps for ensuring their investments generate viable water quality outputs for meeting water quality commitments and reducing water risks.

HIGHLIGHTS

- Corporations active in water stewardship are moving beyond a siloed focus on water quantity challenges and committing to improving water quality and watershed health. Building on the success of "Volumetric Water Benefit Accounting" (Reig et al. 2019), a publication that established an industry standard for implementing and valuing volumetric water outputs of water stewardship activities, this Water Quality Benefit Accounting (WQBA) guidebook provides corporate water stewardship practitioners and project implementers with a six-step process for Water Quality Benefit Accounting.
- WQBA is designed to be applicable across diverse geographies and agricultural, urban, sanitation, legacy contaminant, and landscape management activities that aim to address water quality challenges from sediment, nutrient, bacteria, temperature, and metal pollution.
- WQBA, developed with extensive consultation with relevant parties, provides principle-based, voluntary, and nonprescriptive guidance for companies seeking to make credible water quality benefit (WQB) claims in a consistent way.
- This guidebook provides recommendations for how to select credible projects; quantify water quality outputs, or WQBs, of planned activities; determine attribution of WQBs among project partners; track and report progress toward activity objectives; and communicate claims.
- As the first resource of its kind, this guidebook provides reputable programmatic guidance and methods for companies reporting against water quality goals and gives more companies the confidence they need to make water quality commitments.

Background

Water Quality Benefit Accounting (WQBA) is an approach to support evolution of the private sector as water stewardship activities expand beyond a primary focus on water quantity challenges. Reig et al.'s (2019) Volumetric Water Benefit Accounting (VWBA) guidance has become a best practice resource for companies that invest in water stewardship activities to mitigate risks associated with water quantity challenges and wish to quantify the volumetric benefits of these activities. Increasingly, companies and the public are recognizing the prevalence of water quality challenges worldwide and the importance of having clean water to support economic activities and maintain public and ecosystem health (WWF and GlobeScan 2025). In turn, we are seeing more corporate commitments around improving water quality and watershed health in priority regions. This engagement is also needed to meet public policy targets related to SDG 6.3 on improving water quality by 2030 (UN n.d.).

However, as increased attention is given to water quality goals, there has not been formal guidance to provide consistent, pragmatic, and science-based principles to guide companies in making credible WQB claims that support ambitious enterprise and value chain water quality goals. The principles and steps outlined in this guidance are adapted from VWBA 2.0 (WRI et al. 2025) to help practitioners increase the likelihood that WQB outputs will generate sustainable and beneficial outcomes and impacts that complement sustainable business strategies and mitigate current and future water risks.

About this guidebook

This guidebook offers voluntary, principle-based, and nonprescriptive guidance that is applicable to a broad spectrum of water stewardship activities with water quality–related benefits. The guidance is structured to help select appropriate activities for addressing shared water quality challenges and determine water quality indicators and methods that can be used to quantify, track, report, and communicate the water quality benefits of those activities in a manner that is both practical to implement and technically robust. This WQBA guidance includes agricultural, urban, sanitation, legacy contaminant, and landscape management activities aimed at reducing nutrient, sediment, bacteria, temperature, and metal pollution. Driven by private sector demand, this publication was developed by World Resources Institute (WRI), LimnoTech, and The Nature Conservancy (TNC) with input from corporate partners and technical advisers, ensuring that it meets the needs of the private sector and leverages best available methods and resources. This guidebook may be applicable to a variety of audiences involved in water stewardship activities and was written with two primary audiences in mind: corporate water stewardship practitioners and water stewardship project implementers.

WQBA application

This guidebook outlines six steps that companies can use to identify water stewardship activities and quantify, track, report, and communicate water quality benefits (Figure ES-1).

1. **Understand the local catchment context.** Since water challenges are influenced by local factors that vary significantly across different catchments, it is important to first understand the local context, which can help to identify and prioritize shared water challenges. This first step typically involves building an understanding of the political, hydrological, social, and governance conditions of the catchment as well as identifying relevant parties and their respective roles.
2. **Identify and evaluate potential project activities and partners.** Ensuring alignment between a company's stated commitments and goals and how and where WQBs are generated based on water stewardship activities is essential for making credible claims. In addition, successful execution of water stewardship activities that effectively address shared water challenges will require knowledgeable and reputable implementing partners with local expertise. Ideally, project activities should build on existing efforts in the catchment to maximize impact. Example project activities are provided in Table ES-1. WQBs generated from project activities should align with company goals. A project should
   - have an established pathway for a quantifiable WQB;
   - address water challenges relevant to the catchment or area of interest;
   - have internal buy-in and general support from external water resources entities;
   - deliver a change beyond the without-project conditions that would not have happened without the activity;
   - have an established pathway to track and confirm project water quality outputs; and
   - assess, understand, and minimize trade-offs.

Figure ES-1 | **WQBA application Steps 1-6**

1	Understand the local catchment context	2	Identify and evaluate potential project activities and partners	3	Quantify the WQBs of project activities
4	Plan and agree	5	Implement project and track progress	6	Confirm and prepare for WQB communications

Notes: WQB = water quality benefit; WQBA = Water Quality Benefit Accounting.
Source: Authors; adapted from Reig et al. 2019.

Additional project selection considerations provided in Appendix B can help practitioners prioritize projects to strengthen outcomes and impacts.

3. **Quantify the WQBs of project activities.** Practitioners can identify the objectives of project activities, select the appropriate indicators and methods, and quantify the WQB. The following principles are provided to assist practitioners with quantifying WQBs:
   - Understand the objective of each project activity
   - Use practical and scientifically defensible methods
   - Identify, document, and apply conservative inputs and assumptions
   - Use an appropriate temporal scale
   - Avoid double counting of pollutant loads

Table ES-1 | **Summary of common water stewardship activities with water quality benefits**

CATEGORY	ACTIVITY[a]
Agricultural (field management)	▪ Cover crops ▪ Conservation crop rotation ▪ Agroforestry ▪ No-till or conservation tillage (mulching or mulch tillage) ▪ Nutrient management (fertilizer and manure) ▪ Irrigation efficiency ▪ Contour planting
Agricultural (structural)	▪ Terracing ▪ Edge-of-field windbreaks, vegetated buffers, filter strips, prairie strips, stream setbacks ▪ Filtration devices (bioreactors, phosphorus-sorbing materials) ▪ Grassed waterways ▪ Drainage water management
Urban	▪ Stormwater capture/treatment systems *with* well-defined inlets and outlets ▪ Stormwater capture/treatment systems *without* well-defined inlets and outlets ▪ Wastewater treatment system construction/enhancement
Legacy contaminants	▪ Contaminated site cleanup or treatment systems
Sanitation	▪ Improved sanitation facilities
Natural landscapes and rangelands	▪ Groundwater recharge basin ▪ Wetland creation/restoration ▪ Land conservation or protection/avoided habitat degradation ▪ Restoration of native vegetation ▪ Sustainable grazing ▪ Fire management

Note: [a] Several agricultural activities listed can be classified as regenerative agricultural practices (Ranganathan et al. 2020).
Sources: Compiled by authors. Based on Reig et al. 2019 and Brill et al. 2021.

A variety of methods are provided, with guidance on scenarios for appropriate application:

- Pollutant Reduction Efficiency method
- Simple Method
- Universal Soil Loss Equation method
- Treatment System method
- Water Quality Monitoring method
- Modeling method
- Region-specific methods

4. **Plan and agree.** Practitioners should understand the cost and duration of the activity and work with additional project sponsors to align on an attribution plan for each party to make credible claims. Typically, a cost-share approach is used when there is a clear understanding of total cost, expected outputs, and all parties who are providing financial support.

Prior to project implementation, tracking and reporting plans should be developed by corporate practitioners together with project implementers. Primary tracking and reporting plans should focus on ensuring that implementation activities are completed and on laying groundwork for how the WQB outputs will be quantified. Secondary tracking and reporting of longer-term benefits may also be considered, where feasible. The duration and frequency of project tracking and reporting should align with desired annual WQB claims.

By considering these components and including them in the contracting process, companies can help ensure that they will be well positioned to track, report, and communicate WQBs following implementation.

5. **Implement project and track progress.** Once the project is contracted and the attribution plan and tracking and reporting plans are in place, corporate practitioners and project implementers will execute project activities and document WQB outputs with sufficient information to make WQB claims. Where possible, companies can work with project implementers and tie into existing monitoring efforts to evaluate broader desired outcomes and longer-term levels of impact.

6. **Confirm and prepare for WQB communications.** WQB claims are any statement, accounting, or communication regarding the delivery of existing or anticipated WQBs that result from voluntary actions taken by the entity making the claim. Before making claims, practitioners should confirm that WQBs being claimed are
   - delivered by activities that meet WQB eligibility criteria;
   - aligned with company goals;
   - representative of the activity's status and duration; and
   - representative of the company's contributions to the activity.

Introduction

The introduction outlines the context behind this guidebook, including the state of water quality worldwide and the evolution of corporate water stewardship. It explains the objective of the guidebook – to provide a robust, programmatic, and standardized approach to estimate, track, and communicate water quality benefits of water stewardship activities – and introduces the six principal tasks for applying the guidance. The introduction also provides an overview of its relationship to VWBA, the target audience, how WQBA was developed, the impact pathway of water stewardship activities, and limitations to the guidance.

Background

Until recently, corporate water stewardship efforts have predominantly focused on achieving volumetric (water quantity) goals and quantifying the volumetric water benefits (VWBs) of water stewardship activities supported by corporations, often with an objective of balancing their water consumption. The primary guidance for quantifying VWBs is the Volumetric Water Benefit Accounting (VWBA) method (Reig et al. 2019). This resource has served the water stewardship community well. However, corporations are also starting to consider water quality challenges.

The term "water quality" refers to the chemical, physical, and biological characteristics of water relative to the water's desired use (Cordy 2001). Desired uses include protection of aquatic life and wildlife, drinking water supply, recreation, agricultural uses, and industrial water uses (US EPA 2025). There are many ways water quality may be unsuitable to serve its desired use due to contamination by pollutants (Boyd 2020). In this state, water bodies are considered impaired. Impairments may be driven by various anthropogenic sources such as agricultural runoff, sewage discharge, and the use of lawn fertilizer on urban landscapes (Akhtar et al. 2021). Examples of pollutants and other stressors that can impair water quality can be found in Table 1.

Water quality issues are prevalent worldwide (Damania et al. 2019). McDowell et al. (2020) estimated that 31 percent of the global landmass contained catchments with nutrient concentrations capable of supporting undesirable levels of algal growth. The UN Environment Programme found that roughly

Table 1 | **Common water quality pollutants and stressors**

PHYSICAL PARAMETERS	CHEMICAL PARAMETERS	BIOLOGICAL PARAMETERS
Debris, sediment, plastics, and other foreign objects that are present in the water. Water discharged at high temperatures.	Chemicals in water that can be harmful to human health and the environment.	Harmful microorganisms such as bacteria, viruses, and parasites present in the water. At the community level, these contaminants can cause water-borne illnesses and diseases, such as cholera, dysentery, and hepatitis. Contaminated drinking water or direct contact with contaminated water can be transmission pathways for these diseases.
Examples		
Turbidity, primarily via erosion from watershed soils. Delivery of excess sediment material to a water body can impair aquatic life that requires a rocky substrate for its habit via excess sedimentation. Excessive sediment loading can also cause siltation of waterways and reservoirs, limiting migratory species, affecting aquatic transport, and reducing the lifespan of dams. Note that sediment transport and deposition is a natural part of river systems but that increased erosion from poor land management activities can upset this natural balance.	Nutrients, such as phosphorus or nitrogen, at levels that trigger excessive growth of aquatic plants. Excess plant growth can impair many desired uses of water, such as by creating toxic chemicals due to the growth of certain types of algae (i.e., harmful and nuisance algal blooms) and by aesthetically impairing recreational uses due to water discoloration or excessive aquatic vegetation.	Microbial pathogens from municipal wastewater discharge or runoff from areas of concentrated livestock. These pathogens pose the risk of severe illness to humans after exposure to contaminated water.
Excess temperature, either through discharge of heated effluents, removal of streamside shading, or reductions in groundwater connectivity. Many species of fish require cool water and cannot thrive as temperatures increase. Higher temperatures may also speed up the growth of bacteria in the water.	Other chemical compounds, such as heavy metals or PFAS, that are toxic to humans and/or aquatic life. Humans and wildlife can be harmed by drinking water contaminated with toxic compounds and/or through eating fish or shellfish that have accumulated toxic compounds from the water they live in.	Organic waste, which consumes dissolved oxygen during microbial decay. This causes reduction of dissolved oxygen to levels that harm sensitive aquatic species.
Sources		
Stormwater runoff, erosion, industrial activities	Industrial waste and air pollution, agricultural runoff, stormwater runoff, wastewater discharge	Wastewater discharge, agricultural runoff, animal waste

Note: PFAS = per- and polyfluoroalkyl substance.
Sources: Authors; Damania et al. 2019; Boyd 2020; Akhtar et al. 2021.

one-third of the river reaches in Latin America, Africa, and Asia are affected by severe pathogen pollution, and one-seventh are affected by severe organic pollution (UNEP 2016).

Managing water quality is necessary to protect public health, maintain the health of watersheds and ecosystems, and support economic activities that rely on clean water (Häder et al. 2020; Xu et al. 2022). Due to the shared nature of most water quality challenges, collaboration among relevant parties in the watershed is recommended to adequately and equitably address the challenge. By considering shared water quality challenges, companies can not only protect their own interests but also contribute to sustainable water management practices in the regions that their operations and value chains impact and beyond.

Companies play a role in watershed health through their operations and value chains. A lack of clean water can lead to production disruptions or increased costs for water treatment (Christ and Burritt 2017). Water quality issues can also affect the health and well-being of local communities. For example, in 2014, the City of Toledo, Ohio, temporarily suspended delivery of drinking water from Lake Erie to its residents due to algal toxins caused by excess nutrients fueling an algal bloom (Frankel 2014). Water pollution can have long-term environmental consequences, such as ecosystem degradation and loss of biodiversity. Furthermore, water quality impairments can damage a company's reputation and relationships with relevant parties, especially if they are seen as contributing to the problem.

To address shared water challenges and mitigate their own risks, companies should look at a range of quality parameters across all their locations to determine priority areas and parameters for setting water stewardship commitments that will lead to beneficial water quality outputs, outcomes, and impacts. Part of the solution will include the company's understanding of the root cause and its contribution to the challenge and what change is needed to ensure that it is doing its share to achieve both local and global water quality standards. Guidance on setting contextual water targets at the site (UN Global Compact et al. 2019) or enterprise scale (Reig et al. 2021), guidance for implementing net positive water impact (CEO Water Mandate 2024), and methods on setting freshwater science-based targets (SBTN 2024) can help to inform this process.

To date, most corporate targets related to water quality have revolved around regulatory compliance of wastewater quality and internal corporate wastewater quality standards, with a focus inside their operations, and not in local watersheds or communities. More recently, some corporations have established quantitative water quality targets for their priority areas, some have made qualitative commitments to improve watershed health that include a water quality component, and others with volumetric commitments are interested in capturing water quality improvement as one of the multiple benefits ("multibenefits") of their water stewardship activities. Expanded commitments to, and interest in, water quality improvements have fueled demand for a standardized, consistent approach to quantify water quality benefits and report progress.

Objective

This guidebook aims to provide a robust, pragmatic, and standardized approach to estimate, track, and communicate water quality benefits of water stewardship activities.

The intent of this guidebook is to help companies, project implementers, and others with six principal tasks:

1. Understand the local catchment context
2. Identify and evaluate potential project activities and partners
3. Quantify the water quality benefits of project activities
4. Plan and agree
5. Implement the project and track progress
6. Confirm and prepare for WQB communications

Given the diverse range of catchment conditions and multitude of water stewardship activities a company may support around the world, WQBA has been developed as voluntary, principle-based, and nonprescriptive guidance adapted from VWBA 2.0 (WRI et al. 2025). It provides recommendations for best practices intended to assist companies in making well-founded, robust, and substantiated water stewardship claims that reflect genuine efforts to reduce environmental impacts and promote sustainable practices and outcomes. Companies are also encouraged to consider their environmental impact and social responsibilities beyond the scope of this document's guidance. The application of this

guidance should complement sustainable and just business strategies and water resource-management commitments that consider current and future water risks and impacts.

In addition to supporting water quality commitments that have already been made, developing a framework for water quality benefit quantification can give more companies the confidence they need to make water quality commitments. In doing so, the private sector can lead in many areas where regulations and effective governance have not kept pace with the challenges of the basins. Standardized programmatic guidance and methods can also help mitigate greenwashing risks, as a lack of reputable guidance puts the onus on companies to develop their own accounting methodologies.

Target audience

This guidebook should be of value to a variety of audiences interested in Water Quality Benefit Accounting but is written with two specific audiences in mind:

- **Corporate water stewardship practitioners** involved in designing, implementing, and tracking progress against corporate water goals.
- **Organizations implementing water stewardship projects**, including nongovernmental organizations (NGOs), local community and river basin associations, utilities, engineering companies, and other organizations that leverage corporate support to undertake projects and activities that generate water quality benefits (including as a multibenefit) to substantiate claims against corporate water goals.

WQBA is intended to be complementary to VWBA 2.0 for the purposes of quantifying the water quality benefits of water quality– and/or volumetric-focused activities. Companies and practitioners may use one or both of these resources depending on the kinds of activities they implement in accordance with their interests and commitments. Some activities (e.g., leak repair) will only generate volumetric benefits, some will only generate water quality benefits (e.g., nutrient management), while others (e.g., cover crops, wetland restoration, land conservation) have the potential to generate both volumetric and water quality benefits, which could warrant employing both VWBA 2.0 and WQBA to capture the full suite of benefits.

How WQBA was developed

Based on the objective and audience, WQBA has been developed in close consultation with key relevant parties across businesses, NGOs, reporting programs, government agencies, and academic institutions from around the world to ensure that it is

- **practical and applicable** within the context of corporate decision-making and meets the needs of the target audience;
- **trusted and credible**, informed by published scientific methods, practitioner experience, and water stewardship leading practice; and

- **comparable and replicable**, using a standardized approach and set of indicators that can be applied equally across project types, geographies, and organizations.

The process for developing this WQBA guidance document was carried out in several steps, each of which involved interaction and communication with external relevant parties and advisers. The work was carried out by the project team (i.e., World Resources Institute, LimnoTech, and The Nature Conservancy) with practitioner and technical input from seven corporate partners and advisory group members across the private sector, public sector, academia, and NGOs. The early stages of the effort included assembling the corporate partners and advisory group through collaborative meetings and one-on-one interviews to help refine the WQBA project scope and identify activity types, water quality constituents, and other subjects of interest to be included in the method.

Prior to drafting the WQBA guidance document, a landscape assessment was carried out to inform the method development by gathering existing knowledge on the global water quality challenges and accounting efforts. It included an assessment of the existing tools, datasets, and methods to understand and monitor water quality challenges; existing and emerging standards on water quality; and corporate water quality commitments and the associated methodologies for tracking progress. The landscape assessment also reflected lessons learned from consultations with the project corporate partners and the advisory group.

As the WQBA guidance document was drafted, the core project team shared preliminary products with both the corporate partners and advisory group for vetting, review, and feedback. These intermediate touchpoints ensured consensus on direction and technical content and confirmed that the project was meeting expectations. At the final review stage, the guidance was peer-reviewed by topic experts, target audience members, and reviewers with opposing viewpoints following the research integrity standards of WRI's Research, Data, and Impact team.

Throughout the drafting of the guidebook, the project team aimed to emulate the level of detail, structure, and accounting principles from VWBA, including the updated VWBA 2.0 (WRI et al. 2025) that was developed in parallel to WQBA, with the project teams collaborating on unified accounting guidance that would apply to corporate water stewardship activities aimed at addressing volumetric and water quality challenges.

The impact pathway of water stewardship activities

Water quality benefits are defined as the water pollutant reductions resulting from water stewardship activities that modify the receiving water body in a beneficial way and help mitigate shared water challenges, improve water stewardship outcomes, and meet the targets of Sustainable Development Goal 6 (UN n.d.). This guidebook provides organizations with a recommended approach to identify water stewardship activities to invest in and select appropriate methods to quantify WQBs using different indicators, depending on the activity objective, and report and track results over time. The resulting WQB "output" is based on a consistent approach informed by best practice and provides a unit of measurement to aid in tracking and communicating progress consistently toward water quality commitments, targets, and goals (Figure 1).

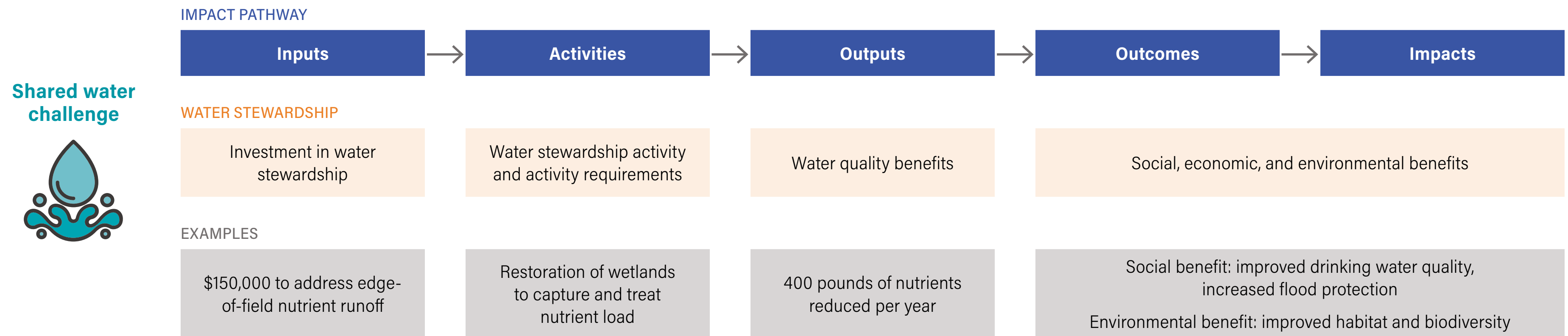
As illustrated in the water stewardship impact pathway, the WQBA approach and associated methods are typically used to quantify WQBs as outputs at the *scale of project activities* and not the downstream social, economic, and environmental outcomes or impacts (see Figure 1). This approach is consistent with how spatial scale is treated in VWBA, and it recognizes three facts:

- The benefit(s) of an activity will generally be most significant and impactful at the local scale.
- The ultimate impact of decreased pollutant delivery to and through downstream water bodies is influenced by various factors that may *attenuate* (reduce) the net benefit. For example, reduced sediment-loading to a river may be negated by increased loading to the river from a different tributary area or resuspension from the sediment bed.
- The estimation of downstream benefits requires the application of more complex methods (e.g., fate and transport models) that typically require a more significant investment of resources than for a standard WQBA method (see Box 1).

Although WQBA was designed to be applied at the project scale, projects that improve water quality may

Figure 1 | **Water stewardship activity impact pathway modified from the social and human capital protocol**

Impact pathway for water stewardship activities



Source: Based on information from WBCSD 2019; modified by authors.

> Box 1 | **Considering downstream water quality impacts beyond WQBA methods**
>
> There may be a stated need or desire to quantify a project's downstream water quality impacts, beyond the calculation of a WQB output. For example, projects that seek to improve the temperature regime in a water body may include regions with existing models that can be used to estimate water temperature impacts or downstream delivery rates of pollutants. If these are not available, it will usually be necessary to conduct targeted monitoring activities and/or develop and apply a mathematical model. Potential monitoring activities should be carefully planned and vetted with experts to ensure that the target condition can realistically be measured in the field. Landscape and surface water models are commonly employed to simulate the impacts of an entire drainage area on a specific water body (river, lake, etc.) but may require significant resources to acquire supporting data, develop and calibrate the model, and conduct the necessary applications. In cases where previous assessments have been conducted in the relevant watershed, existing model simulation results or literature-based estimates (e.g., for pollutant delivery) may also be used.
>
> *Notes:* WQB = water quality benefit; WQBA = Water Quality Benefit Accounting.

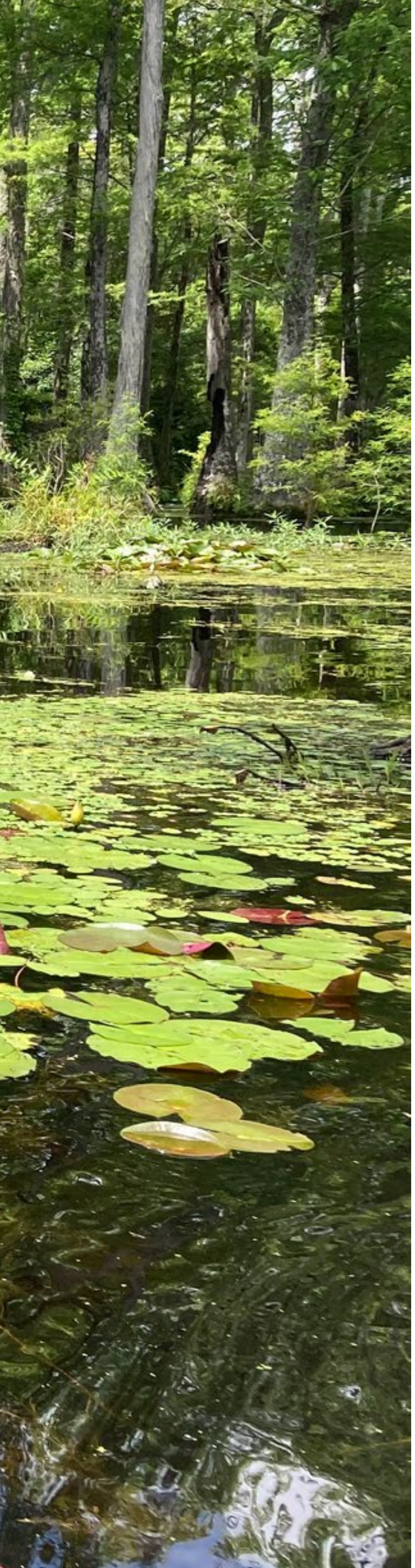
involve one or more activities impacting a specific location or multiple activities that impact larger, noncontiguous areas. The spatial scale of the project is considered as a definable perimeter or boundary around the landscape on which the stewardship activity has taken or will take place, whereas downstream is considered as the place where water leaving the project area flows to, typically combined with flows from other nonproject landscapes, and can range from a few meters to hundreds of kilometers beyond the project boundary. In many cases, project activities will impact water quality not only at the local scale of the activity (e.g., farmland or restored grassland) but also in the downstream landscapes and water bodies that receive pollutant loading from that area. For example, a reforestation activity may reduce the erosion and surface runoff of sediment from the reforested area, and the benefit of reduced sediment delivery from that area will also translate to reduced sediment delivery to, and transport within, river or lake system(s) that the area is tributary to (Gartner et al. 2013). See Box 1 for more information on considering downstream impacts.

Limitations

For successful implementation of WQBA, companies will require a deep understanding of their water use and exposure to risk and catchment conditions. This guidebook will be most relevant to companies with clear and well-defined corporate water stewardship goals and targets for priority basins. WQBA can be used as a resource for selecting projects, estimating and comparing WQBs of water stewardship activities, and tracking and communicating progress of ongoing activities, as part of an organization's water stewardship strategy.

Quantifying environmental, social, or economic benefits is a useful step to ensure that water stewardship activities deliver long-term impact and value. However, aggregating WQB outputs against water quality goals does not guarantee that shared water challenges are reduced in the catchment or that social, economic, or environmental outcomes are delivered, given other actors and activities in the basin that are also impacting water quality. The project eligibility criteria (see Appendix A) and project selection considerations (see Appendix B) provided in this guidebook can increase the likelihood that water stewardship activities generate the kinds of benefits that will contribute to addressing shared water challenges.

WQBA serves as an intermediate and practical step that can yield a consistent and standardized output measurement. Where feasible, quantifying environmental, social, or economic benefits is a useful step to ensure that water stewardship activities deliver intended impact and value; however, quantification may require extensive data and time, and outcomes and impacts may not be detectable until projects are implemented at scale. Additional approaches can be used to quantify environmental outcomes, such as the use of proxy metrics correlated with water quality outcomes or biomonitoring techniques to understand impacts on aquatic life, but these are not included in this guidebook. Extensive engagement with relevant parties suggests that quantifying WQBs is preferable for certain applications, not as an alternative to measuring environmental, social, or economic benefits but rather as an intermediate and practical step that can yield a consistent and standardized output measurement.



Application

This section provides a detailed pathway for identifying and implementing water stewardship activities and communicating associated water quality benefit claims. Detailed step-by-step guidance explains how to (1) understand the local catchment context, (2) identify and evaluate potential project activities and partners, (3) quantify the WQBs of the project activities, (4) plan and agree, (5) implement project and track progress, and (6) confirm and prepare for WQB communications.

This section describes a recommended six-step approach (Figure 2), with detailed guidance and recommended resources, to identify water stewardship activities and quantify, track, report, and communicate the water quality benefits of these activities. These six steps, adapted from VWBA 2.0 (WRI et al. 2025), represent the recommended approach a corporate water stewardship practitioner can follow, informed by decades of practitioner experience and industry best practices around water stewardship. Steps may be undertaken consecutively or in a different order. As is the case for the content in this guidebook, these steps are not meant to be prescriptive but rather to illustrate the kinds of actions that should be taken, and best practices that should be followed, to support the identification and implementation of relevant water stewardship activities and associated claims.

The six steps in the WQBA method (Figure 2) closely resemble those established in the VWBA 2.0 method (WRI et al. 2025) and should be implemented in unison when both VWBs and WQBs are quantified for a given water stewardship activity or program. Each of the six steps involved in the WQBA method is described in greater detail below.

Figure 2 | **WQBA application Steps 1–6**

1	Understand the local catchment context	2	Identify and evaluate potential project activities and partners	3	Quantify the WQBs of project activities
4	Plan and agree	5	Implement project and track progress	6	Confirm and prepare for WQB communications

Notes: WQB = water quality benefit; WQBA = Water Quality Benefit Accounting.
Source: Authors; adapted from Reig et al. 2019.

Step 1. Understand the local catchment context

This step guides practitioners through the process of understanding the local context by identifying shared water challenges and considering company interactions with water in the catchment.

While water quality issues occur globally, WQBA is typically performed considering the local or regional context. This is because the specific nature of water quality issues varies substantially across watersheds, and management actions implemented to address water quality issues provide the greatest benefits in the watershed or catchment where the action is implemented. Therefore, in addition to considering a company's own impacts, developers of water quality projects must understand the local catchment context and shared water challenges, examining the primary socioecological and technical systems and their interrelated impacts within the watershed (McPhearson et al. 2021; UN Global Compact et al. 2019).

Evaluating the local context requires an understanding of the catchment boundaries and physical characteristics, surface water and groundwater conditions, water governance, relevant parties, and known water quality challenges. When possible, engaging with relevant parties within the catchment, including those who are vulnerable and adversely impacted by water challenges, can provide a better understanding of the social and governance context and the values and priorities of relevant parties. Desktop research or outreach may identify water-related efforts already in place or underway, which the organization could contribute to or align with before starting new activities.

Several resources are typically available to identify water quality issues within a local context. In situations where no data or other information is available, or if available information has gaps or is of poor quality, it may be necessary to curate new information through data collection or special studies to properly characterize the local water quality challenges. In these situations, a local water quality challenge is generally understood or highly likely, despite not having any qualitative or quantitative information to properly characterize the issue or issues. When existing resources are present, they can be divided into the following categories:

- Known water quality challenges for the company related to intake water quality or discharge permit requirements
- Consultation with local relevant parties who work in the catchment

- Governmental compendia of local water quality issues
- Academic research studies
- Other public resources

Local relevant parties familiar with environmental issues often provide the best means of identifying local water quality issues. These relevant parties should typically be consulted first, and other resources consulted only if relevant groups do not exist or do not have sufficient familiarity with local water quality issues. Guidance on engaging local relevant parties is available from the Alliance for Water Stewardship (AWS 2020) and UN Global Compact CEO Water Mandate (Brill et al. 2022).

Governmental agencies responsible for environmental protection provide another means for determining local water quality issues. The US Clean Water Act requires states to routinely provide information on the water quality status of all waters in the state (a 305(b) report) and to compile and maintain a list of water bodies impaired by pollutants (a 303(d) list). In Europe, the Water Framework Directive provides a framework for the assessment of water quality across the European Union. EU Member States publish these assessments as part of river basin management plans. These and other publicly available resources that may help companies identify local water quality issues are summarized in Table 2.

In situations where both local and regional or global water quality standards are identified, we recommend that the more stringent of the two thresholds be used in the WQB quantification process.

Table 2 | **Examples of publicly available resources to help identify shared water quality challenges**

AGENCY / RESOURCE	LINKS
US EPA 303(d) lists and 305(b) report	https://www.epa.gov/tmdl; https://mywaterway.epa.gov/
European Water Framework Directive	https://water.europa.eu/freshwater/europe-freshwater/water-framework-directive
UNEP Global Environment Monitoring System for Freshwater	https://gemstat.org/
Australia's State of the Environment Assessments	https://soe.dcceew.gov.au/inland-water/assessments
UNEP Snapshot of the World's Water Quality	unep_wwqa_report_web.pdf
Asian Development Bank Water Development Outlook	https://www.adb.org/documents/awdo-2020-methodology-data
TNC's Resilient Watersheds Toolbox: Pre-Feasibility and How-to-Guide	https://resilientwatershedstoolbox.org/project-cycle/pre-feasibility
Conservation International's Watershed Health Index	https://www.conservation.org/projects/freshwater-health-index

Notes: EPA = Environmental Protection Agency; TNC = The Nature Conservancy; UNEP = UN Environment Programme.
Source: Authors.

Water quality benefits are typically defined for the stressors contributing to the observed water quality impairment. In most cases, the stressor and pollutant are the same. For example, sediment loading is the stressor causing excess sedimentation. In certain cases, however, the stressor may be different than the impairment. Examples of this include nutrients as a stressor contributing to harmful algal blooms or organic matter as a contributor to low dissolved oxygen.

Water quality issues can be caused by a wide range of stressors, with multiple concurrent stressors (or multiple media) having impaired water quality in a single catchment. As such, water quality benefits can also be obtained by addressing multiple different stressors or media. For example, if a catchment is impaired by excess phosphorus and turbidity, implementation of erosion controls can generate benefits for both water quality issues. Another example is a situation where both the surface water and groundwater are impaired by excess nitrogen concentrations. A company reducing nitrogen fertilizer application in its agricultural supply chain could report benefits from the reduction of nitrogen loads to both the groundwater and the surface water, provided the individual load-reduction estimates to each water body can be readily quantified.

While the primary focus of water quality benefits is to address current water quality impairments, catchments with threatened water quality impairments (e.g., on the verge of being impaired and/or trending over time to impairment) are also suitable for claiming benefits. Additionally, any activity that reduces loading of pollutants that modifies water quality in a beneficial way is potentially suitable for the calculation of benefits. Caution should be taken when assessing water quality benefits in the absence of known or threatened impairments, as it is possible, for example, to reduce nutrient or sediment loads to a point where such reductions could disrupt natural processes and proper ecological function (Wohl et al. 2015). Using public resources like those mentioned above or basin-specific plans or studies, practitioners completing the WQB valuation should review available information to determine whether a water body, if not already impaired, is trending toward impairment, as well as whether there may be any unintended negative consequences of the potential stewardship activities.

Defining and aligning with strategic watershed objectives (Box 2) can help identify the type of water stewardship activities that will be most relevant to the catchment context and therefore deliver the most value to the catchment and its relevant parties.

Box 2 | Strategic watershed objectives

A strategic watershed objective refers to a common goal shared by the company and other relevant parties in the catchment that contributes to meeting the shared vision for the watershed. A good strategic objective should aim to minimize or eliminate the root cause of one or more shared water challenges and describe the catchment outcomes it aims to achieve (i.e., the shared vision), considering changes in catchment context over space and time.

Strategic watershed objectives can be defined by considering two key elements: the local watershed context, shared water challenges, key relevant parties, and their water-related values and priorities; and the company interactions with water in that basin, including the company's water-related dependency, risks, and impacts.

Many companies have benefited from defining strategic watershed objectives prior to engaging in water stewardship activities to help guide and inform which water stewardship activities to support and ensure that they deliver the most value to the company, the catchment, and its relevant parties.

Step 2. Identify and evaluate potential project activities and partners

When they are grounded in an understanding of the local context, companies will be better informed about how to choose projects and locations that are in alignment with company goals and local needs. This step provides guidance on selecting project locations and types of projects.

Project eligibility criteria (see Appendix A) are provided, as well as considerations for ranking and selecting projects (see Appendix B). This section aims to provide consistency and assurance to companies that their project investment decisions are aligned with current best practice.

Step 2.1. Consider how and where WQBs may be generated to align with company goals

WQBs are mostly used to track and communicate progress against enterprise and/or site water quality goals and to make claims that a company's goals have been met in line with the company's commitments. Because of this, companies should pay special attention to how and where WQBs are generated to ensure that the type and location of the WQBs and any subsequent claims conform with the company's commitments stated in its goals. Identifying and implementing water stewardship activities that are aligned with company commitments and external expectations will be indispensable for making robust and credible WQB claims. A few key considerations are related to where WQBs are generated:

Desired outcome of the goal. Although less common than volumetric goals, some corporations have established enterprise- or site-level water quality water stewardship goals. In some cases, the goal may specify where the WQBs must be generated to meet the desired objective:

- **Goals aiming to compensate for the pollutant contributions of a company's sites, suppliers, and/or consumers**, such as reduction of water pollutants based on the water pollutant contributions each year of the company's sites, suppliers, and/or consumers. These goals cannot be met by changes in the operational water pollutant discharge of the company's sites, suppliers, or consumers. Instead, this type of goal should be met by WQBs resulting from activities that modify the receiving water body in a beneficial way and help mitigate shared water quality challenges in an amount equal to or greater than the company's water pollutant contribution at that location. Examples of these types of goals include goals to reduce water pollutants at a level greater than contributed by the company in certain watersheds, for example watersheds whose water quality is impaired.
- **Goals aiming to align a company's impacts on water quality with catchment sustainability thresholds**, such as water goals informed by basin surface water quality criteria, groundwater water quality criteria, or targets for pollutant load reduction (e.g., total maximum daily loads [TMDLs]). These goals can be met by WQBs resulting from changes in the water quality pollutant contributions of the company, its suppliers, and/or its consumers to a watershed and by WQBs resulting from activities outside the company in the surrounding watershed. Examples of these goals include water targets or watershed health goals to reduce pollutants in relation to the desired condition.
- **Non–water quality goals that create the opportunity to quantify water quality multibenefits**, such as volumetric-based water restoration or replenishment goals driving implementation of activities that modify the hydrology in a beneficial way, yet also providing water quality benefits.

Geographic scope of the goal. Water quality goals typically specify in which geography the WQBs must be delivered to meet the goals:

- **Goals focused on addressing company risks** should be met with WQBs generated in areas facing water quality risks relevant to the company's value chain footprint.
- **Goals focused on addressing company impacts** should be met by WQBs generated in a catchment that is hydrologically connected to the location from which the company affects water resources through its wastewater discharge or diffuse sources.

Step 2.2. Identify potential project activities and partners

The next step is to identify potential watershed activities and partners. These may include activities driven by the public, private, or nonprofit sectors.

Project activities should have the potential to address water quality–related shared water challenges and, where relevant, align with existing efforts to address water quality issues. Coordination with reputable and experienced implementing partners can improve the likelihood of success as they can help evaluate potential trade-offs and minimize the likelihood of unintended negative impacts. A list of example activity classifications understood to have WQBs is provided in Table 3.

Step 2.3. Apply eligibility criteria and selection considerations to evaluate potential project activities and partners

After considering how and where WQBs may be generated to align with company goals, identify a preliminary set of potential activities and partners using the following decision framework (Figure 3) comprising key criteria and considerations that fall into two categories:

- *Project eligibility criteria* (see Appendix A) are essential, and therefore must be met, for a project to be eligible to generate a quantifiable WQB.

Table 3 | **Common water stewardship activities understood to have WQBs, arranged by different categories**

CATEGORY	ACTIVITY[a]	EXAMPLE PROJECT DESCRIPTIONS
Agricultural (field management)	Cover crops	Planting a noncash crop to add soil cover during otherwise fallow conditions between commodity crop seasons. Increases cover, infiltration, nitrogen fixation (certain species), retention of excess nutrients; decreases soluble nutrient mobilization, soil erosion.
	Conservation crop rotation	Practicing a more diverse cash crop rotation (i.e., avoiding monocrops). Improves soil health; decreases nutrient inputs, nutrient losses, soil erosion, pesticide use.
	Agroforestry	Integrating trees or shrubs into crop or livestock operations. Increases canopy interception, infiltration; decreases runoff rates and volumes, soil erosion.
	No-till or conservation tillage (mulching or mulch tillage)	Minimizing soil disturbance by switching from conventional tillage (e.g., plowing). Increases cover, organic matter, water-holding capacity, microbial activity; decreases raindrop impact, soil detachment, erosion.
	Nutrient management (fertilizer and manure)	Practicing the 4Rs of nutrient management, including both inorganic fertilizers and manure, using the right source of nutrients, applying nutrients at the right rate and right time, and putting them in the right place. Increases profitability, crop use efficiency; decreases runoff losses, input costs.
	Irrigation efficiency	In situations where overirrigation results in leaching or runoff losses of nutrients or other pollutants, introducing irrigation efficiency measures can improve water quality in surface water or groundwater.
	Contour planting	Planting perpendicular to land slope, including alternating crops planted in contour strips. Decreases soil erosion.

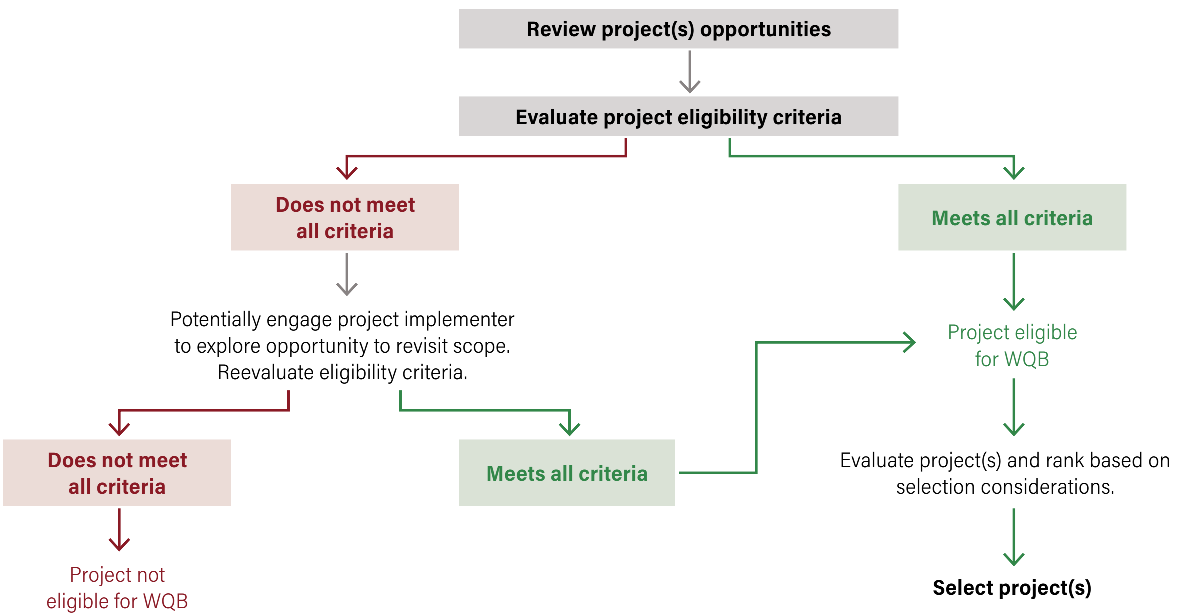
Table 3 | **Common water stewardship activities understood to have WQBs, arranged by different categories (cont.)**

CATEGORY	ACTIVITY[a]	EXAMPLE PROJECT DESCRIPTIONS
Agricultural (structural)	Terracing	Constructing terraces or benches perpendicular to slope on relatively steep terrain. Increases infiltration; decreases runoff rate, soil erosion.
	Edge-of-field windbreaks, vegetated buffers, filter strips, prairie strips, stream setbacks	Planting vegetation along field boundaries, typically perpendicular to overland flow paths and adjacent to water conveyance systems. Increases infiltration; decreases soil transport, nutrient runoff, overspray risks.
	Filtration devices (bioreactors, phosphorus-sorbing materials)	Routing surface or subsurface runoff through constructed treatment systems, often intended to reduce losses of a problematic pollutant.
	Grassed waterways	Planting dense native grasses or other native vegetation (sedges, shrubs) along concentrated flow paths within fields. Increases filtration; decreases soil transport, nutrient runoff.
	Drainage water management	Seasonal or year-round management to retain drainage water for slower release, increased infiltration, or reuse.
Urban	Stormwater capture/treatment systems *with* well-defined inlets and outlets	Engineered structures to which stormwater runoff is routed for the purposes of reducing peak flow rates, providing temporary or permanent storage volume, and/or reducing pollutant loads (e.g., bioretention, detention and retention ponds, filtration devices).
	Stormwater capture/treatment systems *without* well-defined inlets and outlets	Engineered structures intended to reduce stormwater runoff volumes or slow runoff rates by temporary or permanent storage or increased infiltration (e.g., green roofs, permeable pavement, filter strips, riparian buffers, green space, urban tree canopies).
	Wastewater treatment system construction/enhancement	Building new, upgrading, or improving existing municipal wastewater treatment systems that remove or reduce discharge of harmful pollutants from effluent streams to water bodies.
Legacy contaminants	Contaminated site cleanup or treatment systems	Activities to improve surface water or groundwater quality by treating or otherwise mitigating contaminant hotspots, such as acid mine drainage treatment systems, installation of groundwater treatment wells, or removal of contaminated soils.
Sanitation	Improved sanitation facilities	Sanitation access activities that improve the water quality of wastewater (including sewage and fecal sludge), either on-site or off-site from where it was produced, to the point where it can be safely discharged or reused.
Natural landscapes and rangelands	Groundwater recharge basin	Natural structures that intercept and store surface runoff, allowing it to percolate through the soil profile and recharge groundwater aquifers.
	Wetland creation/restoration	Restoring degraded or converted wetlands to a more functional state, or creating new wetlands where they previously did not exist, to provide wildlife habitat, restore hydrologic function, introduce native vegetation, and other multibenefits.
	Land conservation or protection/avoided habitat degradation	Legal mechanisms to protect land from development or conversion to a more degraded use.
	Restoration of native vegetation	Restoration to improve vegetative health and cover, including reforestation (e.g., tree planting in deforested areas, post-wildfire mitigation, riparian buffers, thinning of monoculture forests, agroforestry, prairie and other grassland restoration, invasive species removal).
	Sustainable grazing	Implementing a variety of actions on natural landscapes used for animal grazing (i.e., rangelands/grasslands/prairies) to promote or restore healthy soil and vegetative cover (e.g., rotational grazing, fencing, reseeding, water supply relocation).
	Fire management	Restoration of landcover to support a natural fire regime and reduce the risk of postfire pollutant runoff (e.g., forest thinning or controlled burn).

Notes: WQB = water quality benefit; [a] Several agricultural activities listed can be classified as regenerative agricultural practices (Ranganathan et al. 2020); The classification above includes the most commonly implemented water stewardship activities by corporate water stewardship practitioners at the time this guidebook was written. This list is not comprehensive, and organizations are encouraged to also consider other activities that respond to local shared water challenges and relevant parties' priorities.

Sources: Compiled by authors. Based on Reig et al. 2019 and Brill et al. 2021.

Figure 3 | **Flow diagram outlining project selection process**



Note: WQB = water quality benefit.
Source: Authors.

- *Project selection considerations* (see Appendix B) support practitioners in identifying, ranking, and selecting projects based on additional considerations beyond what is covered by the project eligibility criteria. Project selection considerations can strengthen the outcomes of a water stewardship activity but are not required to generate WQBs.

Project eligibility criteria

Eligibility criteria are essential elements that must all be met for a project to be eligible to generate a WQB. They intentionally exclude requirements focused on how a WQB claim can be made, which is a topic covered in Step 6. The six criteria are described in Appendix A and aim to guide practitioners in selecting relevant projects. They include the following:

- The activity has an **established pathway for a quantifiable WQB**, backed by sound and consistent calculation methods and principles that are aligned with best practice.
- The activity **addresses shared water challenges that are relevant** to the catchment or area of interest.
- The activity has **internal buy-in and general support** from external relevant parties, communities, and/or experts familiar with the basin context and shared water challenges.
- The activity **delivers change beyond the without-project conditions** (ones that would not have happened without it), and it is not legally required by the project sponsor for compliance purposes.
- The activity includes an **established pathway to track WQB outputs** that can be evaluated in future years to ensure continued function and water quality benefit for the intended duration of WQB claims.
- The activity **trade-offs have been assessed, understood, and minimized** to make sure it does not adversely affect one entity to the benefit of another or result in opposition that could lead to reputational risk to project developers, sponsors, or benefactors.

Project selection considerations

Project selection considerations can help practitioners prioritize and select projects that ensure the greatest likelihood of success, and contribute to broader social, economic, and environmental outcomes that extend beyond WQB outputs. Elements listed below help ensure project value but are

not required for a project to generate WQBs. The selection considerations, described in Appendix B, include the following:

- Minimal risk of project failure or underperformance
- Project implementer readiness and capacity
- Clarity on project costs and cost shares among funders
- Feasible project implementation timeline
- Anticipated duration of WQBs consistent with desired timeline
- Location relevant to water goals
- Opportunity to deliver multiple benefits
- Enabling projects
- Innovative strategies
- Opportunity for collaboration

These criteria and considerations are intended to serve as guidance for companies. It will be up to individual companies to apply criteria and considerations in their own decision-making process for WQB project selection. The relevance of individual criteria and considerations may vary based on a company's exposure to risk, water goals, strategic watershed objectives, and project scale. For example, it may be more challenging to evaluate all criteria and considerations for transformational projects that involve activities on a very large scale. Therefore, additional flexibility and adaptation may be needed for some criteria, particularly those related to community consultation or identification of potential trade-offs.

Step 3. Quantify the WQBs of project activities

WQB quantification is guided by the following principles and the four steps described herein. These steps can be followed to quantify WQBs at the project planning phase (i.e., for a preliminary WQB estimate) and/or after project implementation. Adherence to the following principles is essential when quantifying WQBs:

- **Understand the objective of each project activity** to inform the selection of the appropriate WQB indicator and method.
- **Use practical and scientifically defensible methods** that are relatively simple to apply.
- **Identify, document, and apply conservative inputs and assumptions** to avoid overestimation and build trust in the results.
- **Use an appropriate temporal scale** that can account for variability in conditions associated with seasonality in shared water challenges.
- **Avoid double counting of pollutant loads,** keeping in mind that the same pollutant load reduction may provide multiple benefits, but each unit of load should not be counted more than once.

The four steps described below can assist practitioners in the selection of WQB indicators and methods to address activity-specific objectives and should be applied using the tables in Appendix C. If needed, engage a subject-matter expert to support the selection of an appropriate WQB indicator and method.

These steps have been developed recognizing that organizations may be interested in supporting a wide range of potential activities and can apply each of the methods in many ways. These range from simple estimates (typically used during early-stage project evaluation and cost-benefit analysis of project cost vs. WQBs generated) to more detailed, robust, and complex estimates or measurements (typically used to report progress, communicate publicly, and make claims regarding an organization's water stewardship activities associated with investing in water quality improvement projects and watershed health more broadly).

Step 3.1. Identify the water quality objective

After identifying a proposed project activity, confirm the objective of the activity (i.e., how the activity contributes to addressing a shared water challenge). Although many watershed activities will not have a WQB output as the main objective, and in many cases will have more than one objective, it is necessary to define a water quality–related objective to identify an appropriate WQB indicator. Examples of common water quality objectives include, among others, reducing nutrient loading, preventing sedimentation, ensuring safe drinking water, improving water quality conditions for aquatic life, and creating healthy water conditions for human recreation.

Note that while the objective informs the selection of the indicator, and the indicator informs the method used to quantify the outputs of the activity, the scale of the activity may not be sufficient to result in a measurable change in a shared water challenge despite having a quantifiable benefit at the project scale. For example, a single activity can result in reduced pollutant loads at a given location (i.e., the output) but not at a scale that would lead to measurable regional water quality improvements.

Step 3.2. Select the WQB indicator

Based on the water quality objective and how the activity helps reduce shared water challenges (by reducing pollutant load, avoiding pollutant load, reducing pollutant concentration, etc.), select an appropriate WQB indicator (Table 4). For example, if water body eutrophication is the primary water quality impairment of concern, then excess nutrients (i.e., nitrogen and/or phosphorus) are the most appropriate pollutants, and pollutant load reduction is the most appropriate indicator to define and quantify measurable improvements associated with project implementation. As another example, a company's operations in a catchment may impact water temperature regimes in receiving surface water bodies through thermal discharges. Therefore, the company may seek to implement water stewardship activities where a percent reduction in average or peak water temperatures is the most appropriate

Table 4 | **Water quality benefit indicators**

INDICATORS
Reduced pollutant load
Avoided pollutant load
Percent pollutant concentration reduction
Average temperature percent reduction
Peak temperature percent reduction

Source: Authors.

indicator. The units of a WQB will be unique for each combination of pollutant and selected indicator; therefore, any aggregation of WQBs should carefully consider alignment of units and pollutant types.

Step 3.3. Select the WQB method

Based on the objective and WQB indicator and pollutant, select an appropriate method from the list of predefined WQB methods (Appendix D). Appendix D describes seven WQB calculation methods, including example calculations and case study applications for certain methods.

When relevant, consider using other credible, well-documented, and scientifically defensible methods and approaches that are aligned with the principles listed above and can support WQB calculation for the relevant indicator. Examples of such methods include local or regional water quality models and activity-specific empirical measurements or observations.

Step 3.4. Gather required data and calculate WQBs

Lastly, define the time scale for measuring and communicating WQBs, gather the data, and calculate the WQB indicators for the with- and without-project conditions. When possible while evaluating what type of data to gather, partners should consider the context and relevance of available data. The WQB can then be quantified based on the difference between the with- and without-project conditions. Results obtained from the WQBA method should be carefully checked and critically evaluated to ensure that they provide a defensible estimate of the benefit (Appendix F).

Special attention is required when quantifying the WQBs resulting from activities that aim to address seasonal shared water challenges, such as seasonal water quality impacts, to make sure that WQBs reflect the water quality improvements at the corresponding time of year to address the shared water challenges. WQBs often involve total annual load reductions for common pollutants; however, there may be situations where cumulative (multiyear) load reductions or seasonal (partial year) load reductions are more appropriate temporal periods for a WQB.

Step 4. Plan and agree

In addition to considering the total projected WQB generated by potential project activities, final project selection should be informed by an understanding of the attribution of those benefits across project sponsors and implementers, the anticipated duration of the activities and anticipated WQB claim, and the tracking and reporting plan. Where possible, when multiple project sponsors are involved, there should be alignment among all parties to apply a consistent method and approach for WQB quantification. By considering these components and including them in the agreement process, companies help ensure that they will be well positioned to track, report, and communicate WQBs following implementation.

Step 4.1. Consider the cost and duration of the activity

Information on cost, implementation timeline, and duration of the activity will provide a preview of the resource requirements, cost-benefit ratio (i.e., project cost over WQB), and timing of future claims related to the activity, including how much of the WQBs can be attributed to each project sponsor as well as when to start claiming and for how long.

The timing of the claims and the duration of benefit claims will vary depending on the activity; details on how to communicate these claims are provided in Step 6.

Step 4.2. Align on a WQB attribution plan

There are many ways companies can work with others to support water stewardship activities that yield WQBs, including bilateral engagements between a company and a project implementer, transactions between buyers and sellers within an environmental marketplace, as well as multilateral and collective action engagements between multiple companies, government agencies, and/or civil society groups.

Regardless of who is involved in supporting the water stewardship activity, clear, transparent, and conservative attribution of WQBs is foundational to making credible claims and communicating WQB results. Because of that, prior to supporting an activity, the approach for attributing WQBs should be determined and agreed upon between project sponsors and implementers. An approach for reporting WQBs in future years should also be determined. This will help ensure aligned expectations and clear communications between project sponsors and implementers when communicating the resulting WQBs and help minimize the reputational risks of overclaiming.

When new project sponsors join and start to contribute to a water stewardship activity that has been ongoing and previously supported by other sponsors, project sponsors and implementers should align on how to attribute WQBs moving forward by considering how the additional support from new sponsors expands the scope and results of the activity and/or otherwise modifies the activity and resulting WQBs.

Independently of how many project sponsors are involved, companies claiming WQBs resulting from water stewardship activities should apply credible and transparent approaches to attributing WQBs being claimed.

Credible approaches to attribution of WQBs can be defined as follows:

- **All parties involved can stand behind them.** The company making the claim, the other project sponsors, and the project implementers should all be able to stand behind the attribution of WQBs among parties involved, based on their shared understanding of the cost, funding sources, and resulting WQBs.
- **Attributed WQBs are proportional to the contribution of the company making the claim.** The company making the claim should attribute WQBs in a way that reflects the company's overall contribution to the activity and resulting WQBs (e.g., monetary or in-kind).

The following common considerations should be kept in mind when exploring approaches to attribute WQBs in these two scenarios:

When there is clear visibility into the total project cost, and project outputs are primarily water quality benefits

In most cases, when there is a clear understanding of the total cost and the expected outputs of a project are primarily water quality benefits, WQBs resulting from a company's contribution to the project can be attributed using the cost-share approach. Following the cost-share approach, the total WQBs resulting from the project are attributed to each project sponsor based on its proportional contribution to the total cost of the project.

When following a cost-share approach, it is important for project sponsors financing the project and project implementers to agree on what is included in the total cost. For example, the total cost of a project could be determined based on the activity's capital expenditures (CAPEX) plus the project's operating expenditures (OPEX) plus any design, permitting, land acquisition, monitoring, and evaluation costs over the lifetime of the project or expected duration of the claim. The project's CAPEX refers to the capital expenditures required to implement the project in the first place; the project OPEX should apply to any additional resources required to ensure essential day-to-day costs that are necessary to maintain the project over time. In-kind contributions of time and/or materials provided to a water stewardship project are often excluded but can also be quantified monetarily and included as part of the CAPEX or OPEX when relevant.

When there is an unclear pathway for WQB attribution (e.g., new activity type, voluntary markets, credit-based environmental products)

Consider attributing and claiming WQBs when the following characteristics are in place:

- **Intentionality:** WQBs being claimed were intentionally created with a predefined purpose and specific water stewardship outcome that addresses shared water challenges and is documented as part of the transaction between, on the one hand, a project funder or sponsor and, on the other, a project developer or implementor (e.g., the buyer and seller).
- **Additionality:** The creation of the WQBs and cost paid for the WQB-generating project reflects (and is directly relevant to) the cost, labor, or endeavor of generating the WQBs or multiple benefits that include WQBs being claimed.
- **Permanence:** The WQBs are retired and correspond with a retirement schedule or timeline that aligns with the duration of the claim.

WQBs should be quantified in line with recommendations outlined in this guidebook and documented in the bills of sale, contractual documents, or other documentation to help demonstrate and substantiate the intentionality, additionality, and permeance of the WQBs.

In situations where project sponsors struggle to identify a credible and transparent approach to WQB attribution, companies should consider engaging a subject-matter expert and/or consulting external relevant parties to determine how best to support robust, credible, and transparent WQB claims.

Step 4.3. Make a tracking and reporting plan

Prior to project implementation, WQBs are calculated based on the expected performance of a planned project over a specified period. Because project scope, cost, and timeline may change during implementation, after all project implementation activities are completed, a project's performance and WQBs should be confirmed, documented, and tracked through the collection and assessment of information confirming that the project was implemented as proposed, WQBs are being delivered, and key project performance factors necessary to generate WQBs are established and sustained (as described in Appendix E).

A wide range of water stewardship projects are implemented in diverse locations and circumstances. As a result, uniform or standardized monitoring and data collection to support performance tracking and reporting across all projects in all locations is not practical. Nevertheless, companies seek projects where tracking and reporting can provide credible information that substantiates WQB claims and progress against their water goals. In all cases, tracking and reporting plans should be practical and feasible for project implementers to carry out, including developing realistic and manageable tracking and reporting strategies that can accommodate long-term, large-scale, and/or programmatic approaches that generate WQBs.

Project tracking and reporting guidance is provided in Appendix E.

Step 4.4. Formalize contribution, commitment, and support for water stewardship project

Once the steps above are complete, companies should jointly develop and execute agreements (e.g., contracts, memoranda of understanding, funding agreements) to specify and memorialize roles and responsibilities of the company and key project implementation partners. Agreements provide a critical opportunity in the project development life cycle to confirm understanding and expectations among parties responsible for project funding, implementation, performance tracking, and reporting.

Project agreements can be used to memorialize expectations and may include

- implementation timelines and performance benchmarks;
- reporting and tracking timelines and responsibilities;
- funding amounts, matching funds, and disbursement steps;
- duration of project benefits and WQB generation;
- project maintenance needs and responsibilities;
- joint publicity language regarding WQB claims and partner roles;
- expectations regarding site visits; and
- other key project details.

Many of the activities noted above cannot be delivered or sustained without multiyear funding, and ideally agreements will clarify how desired activities (e.g., long-term reporting, site tours, essential project maintenance) will be supported.

Step 5. Implement the project and track progress

Once project agreements are in place, partner roles defined, and resources for the project committed, project implementation can occur. Implementation can take many forms and may occur quickly in a single location or over many years across an array of sites. Companies should track and understand implementation progress in a way that aligns with expectations established in Step 4.4. This may involve reviewing annual reports, visiting project sites, ongoing communication with relevant parties, or other methods that allow for tracking of implementation progress.

Project tracking should confirm that key actions required to make a WQB claim (Step 6) are in place. Optionally, companies may refer to Box 3 for guidance on tracking longer-term outcomes and impacts.

Box 3 | Longer-term impact and outcome tracking

Some companies have interests that extend beyond project-level WQB outputs and may seek information regarding progress toward desired outcomes and long-term impacts. These interests may include delivery of multiple benefits, such as water quality improvement, ecosystem biodiversity, or socioeconomic improvement. If regional or site-specific indicators are available and can be readily quantified for water quality outcomes or long-term impacts, then practitioners may select these complementary indicators in addition to the WQB outputs. Examples encountered include indices of biological integrity, harmful algal bloom biomass reduction, or an additional number of days a water body is meeting a regulatory standard or is available for a beneficial end use (e.g., fishing and swimming). A company's involvement at this level requires a deeper and longer-term commitment, with a higher degree of local interaction and sustained financial participation. Funding for long-term tracking and reporting that is focused on outcomes and strategy effectiveness is often difficult to secure. Companies with an interest in and understanding of the high level of sustained commitment required to accomplish this important but challenging task may be able to fund or participate in longer-term roles to facilitate tracking of outcomes or strategy effectiveness.

There are also situations where systems and funding may already be in place to track progress toward longer-term desired outcomes. Many catchment- or landscape-scale initiatives are supported by multiple public and private funders, each with their respective tracking and reporting needs and requirements. For example, regional water stewardship initiatives led by a partnership of project implementers (e.g., tribes, agencies, and nongovernmental organizations) will sometimes have long-term monitoring systems in place that are designed to evaluate strategy effectiveness and progress toward long-term goals. Where such information is available, companies should work with project implementers to obtain available reports and data that evaluate broader levels of impact. Such information can be used to improve understanding of strategies and challenges, inform future action, and augment project reporting.

Note: WQB = water quality benefit.
Source: Authors.

Step 6. Confirm and prepare for WQB communications

This section was developed to assist companies with making credible WQB claims, while incentivizing water stewardship activities that address long-term shared water challenges.

A WQB claim is defined as any statement, accounting, or communication regarding the delivery of existing or anticipated WQBs that result from voluntary actions taken by the entity making the claim. As referred to herein, WQB claims exclude action, statements, or communications needed to meet regulatory or externally imposed compliance requirements unless those clearly specify the need for WQBs as defined in this guidebook.

Step 6.1. Confirm that WQBs being claimed are delivered by activities that meet WQB eligibility criteria

Ensuring that the six essential eligibility criteria outlined in Step 2.3 ("Apply eligibility criteria and selection considerations") are met demonstrates that water stewardship activities can generate WQBs in ways that are credible and trusted by external entities.

Checklist of required evidence to support credible WQB claims:

- ☐ Quantity of WQBs (total produced by the activity as well as fraction attributed to company)
- ☐ WQB method, indicator, calculations, and data sources
- ☐ Evidence that the activity addresses one or more shared water quality challenges present in the catchment or area of interest
- ☐ Evidence that the activity has internal buy-in and support from external relevant parties
- ☐ Confirmation that the activity delivers positive change and/or prevents a negative impact beyond the without-project condition and is not legally required by the project sponsor
- ☐ Confirmation that there is an established tracking and reporting plan
- ☐ Confirmation that trade-offs are assessed, understood, and minimized

Step 6.2. Confirm that WQBs claimed are aligned with company goals

Because WQB quantification is typically used to assess progress toward a company's goals, the type and location of activities and resulting WQBs should be in line with a company's water goals.

Some company goals may lead to aggregation of water-related benefits across a portfolio of projects. However, aggregation of WQBs requires careful consideration and clear communication to avoid misstating benefits. While VWBs have a single unit definition of volume of water per unit time regardless of indicator, the units of a WQB are more complex and will be unique for each combination of pollutant and selected indicator (Table 4). Aggregation of WQBs should be handled differently than that of VWBs, and where necessary the different pollutants, indicators, and temporal scales should be distinguished. The following are guidelines regarding aggregation of WQBs:

- WQBs should only be added for the load-reduction indicators for common pollutant types.
- WQBs expressed as percent concentration reduction or percent temperature reduction cannot be added across multiple projects. Instead, average or median values and/or ranges can be used to summarize the impacts of multiple projects.
- Typical temporal aggregation of WQBs involves total annual load reductions for common pollutants. It may be necessary to express multiyear or seasonal (partial year) WQBs as an annual load reduction.

The practitioner should consider any other programmatic factors that may be relevant for the claim, addressing questions such as the following:

- How do the WQBs contribute, or link, to other company business and sustainability objectives?
- How does the claim fit within the overall timeline and duration of the commitment?
- What was the role of the company and its partners in meeting the claim?

- How can the claim contribute to increasing brand value and visibility?
- What story does the company want to tell? What role in the project does it want to play? What sort of relationships does it want to build?

This list of questions is not exhaustive, and companies should also consider other relevant factors.

Checklist of required evidence to support credible claims related to where and how WQBs contribute to company goals:

- ☐ Confirmation that the WQBs being claimed fit within the timeline, duration, and business and sustainability objectives of the company's commitment
- ☐ Confirmation that the WQBs being claimed align with the company's internal requirements for meeting the company's water goals

Step 6.3. Confirm that WQBs being claimed are representative of the activity's status and duration

Before claiming WQBs, ensure that the project implementation activities are completed and performance factors are in place, as outlined in Step 4.

For many types of activities, WQBs may not be generated for several years due to the time required to contract for, design, and implement an activity to the point where it can generate WQBs. During that time, project sponsors may communicate and claim anticipated WQBs or WQBs under contract to help convey progress toward goals while not overclaiming actual WQBs delivered. Communicating and/or claiming anticipated WQBs or WQBs under contract may be a better indicator of progress against goals when a company is supporting longer-term activities or is required to report progress to internal or external relevant parties at a higher frequency than it can deliver WQBs on the ground.

Anticipated WQBs or WQBs under contract can be defined as the WQBs expected to be delivered because of a company's contribution to an activity that is under contract within the reporting period but has not yet delivered WQBs. Anticipated WQBs or WQBs under contract should represent a realistic and credible quantity of the WQBs anticipated once all implementation activities and performance factors are in place.

The timing and duration of WQB claims will vary depending on the activity. Consider the status and duration of the activity and, based on that information, determine when to start and for how long and when to stop claiming WQBs.

When to start claiming WQBs

For new or enhanced gray infrastructure, the WQBs are expected to be delivered and can be claimed

- as soon as the project's implementation activities are completed, *and*
- the project performance factors are in place.

For new, enhanced, or protected green infrastructure, given the potential timeframe for project maturity, the WQBs are expected to be delivered and can be claimed

- in full as soon as the project's implementation activities reach levels of expected or required hydrologic performance, *or*
- in part, proportional to the status and performance of the activity, *and*
- the project performance factors are in place.

For behavior and practice changes, the WQBs are expected to be delivered and can be claimed

- as soon as the project's implementation activities are completed, *and*
- the project performance factors are in place.

How long to claim WQBs

Engaging and investing in activities that reduce shared water challenges is important to reduce water-related risk and enhance a company's social license to operate. Sustained engagement and involvement to ensure that funded activities continue to function are encouraged for the duration of WQB claims.

Companies can claim WQBs if *both* the following are true:

- The implementation activities are functioning as designed, and there is reasonable evidence that the project performance factors tied to the generation of WQBs are in place (i.e., the activity continues to have an impact).
- The company making the claim is actively involved and/or supporting the ongoing functioning of the activity through the initial investment or ongoing investments (e.g., the company is engaged directly or indirectly in the operation and maintenance, or the company has funded all requested years of tracking and reporting, making its claim credible and relevant and its contribution accountable). Active involvement could also include advocacy for the project, participating in forums related to addressing shared water challenges in the catchment, discussions of necessary next steps, coordinating volunteer actions, and so on.

To help incentivize new and innovative investments and engagements in water stewardship, companies may want to consider observing two conditions:

- Continuing to claim WQBs after a water quality goal is met only when the company's involvement in the activity continues to scale meaningful impacts across the catchment (e.g., when the activity was implemented shortly before the goal was met).
- Setting a duration limit to the claim to demonstrate to relevant parties an enduring commitment to participate in addressing shared water challenges and avoid reputational risk related to inaction for extended periods.

When to stop claiming WQBs

Companies should consider no longer claiming WQBs when

- the company is no longer involved and/or supporting the ongoing functioning of the activity or working to address shared water challenges, *or*
- the company's initial capital investment is fully depreciated, *or*
- the implementation activities are no longer functioning as designed, *or*
- the status of project performance factors is unknown or cannot be confirmed.

Checklist of required evidence to support credible claims:

- ☐ Status of the project's implementation activities (e.g., percentage of activity completed)
- ☐ Confirmation that the project implementation activities and performance factors are in place (e.g., performance monitoring or attestation report for the period being claimed)

- ☐ Confirmation of the company's ongoing tracking, support, and/or contribution to the project

Step 6.4. Confirm that WQBs being claimed are representative of the company's contributions to the activity

In alignment with Step 4.1, companies making WQBs claims should consider communicating the total WQBs resulting from an activity (i.e., the collective WQBs achieved because of all project sponsors), as well as the WQBs attributed to the company making claims (i.e., the fraction of the total WQBs proportional to the company's contribution to the activity). When total WQBs are communicated, it is important to be very clear that the total WQBs are not the same as the WQBs attributed to the company making claims.

This will help convey the collective impact of a company's participation in water stewardship activities while recognizing the company's individual contribution to the activity.

Checklist of required evidence to support credible claims:

- ☐ Clear documentation of the agreed-upon attribution approach
- ☐ Total WQBs resulting from activity
- ☐ WQBs attributed to the company making the claim (when there are multiple project sponsors)

Appendices

The appendices provide supplemental information to support the application of the six steps. It is most relevant for technical readers who are executing WQBA. The information includes more detail on project eligibility criteria and selection considerations, guidance on selecting appropriate water quality indicators and methods, detailed technical calculation methods for seven types of methods, and more details on performance factors for ensuring generation of water quality benefits.

Appendix A: Project eligibility criteria

Eligibility criteria are essential elements that should be met for a project to be eligible to generate a water quality benefit (WQB). They intentionally exclude requirements focused on how a WQB claim can be made. The primary value is that the eligibility criteria will guide practitioners in selecting relevant projects that exhibit the following characteristics:

- They have the potential to generate WQBs that are backed by sound and consistent calculation methods and principles that are aligned with best practice.
- They have a contextual basis and deliver value to address shared water challenges beyond a condition that currently exists or would occur without the activity.
- They do not adversely affect one entity to the benefit of another or result in opposition that could lead to reputational risk.
- They do not lead to unintended negative outcomes that are problematic for those who rely on or advocate for the water resource.
- They can be evaluated in future years to ensure that they continue to function as designed and provide a water quality benefit for the intended duration of WQB claims.

The six WQB eligibility criteria are defined below, with recommendations for how a practitioner can evaluate and determine what is needed to meet the criterion.

1. Established pathway for a quantifiable WQB

The project generates water pollutant reductions resulting from water stewardship activities that modify the receiving water body in a beneficial way and help reduce shared water challenges, and the change can be measured or estimated by comparing with- and without-project conditions according to the Water Quality Benefit Accounting (WQBA) method or another method aligned with the principles of WQBA.

How to meet this criterion? Identify the objective of the activity and confirm that the activity helps address a shared water challenge. Identify the indicator and confirm that the water quality benefit of the activity can be quantified using the WQBA method or another method aligned with the principles of WQBA.

2. Water challenges addressed relevant to the catchment or area of interest

The project addresses one or more shared water quality challenges present in the catchment or area of interest. Water-related challenges are documented and/or well understood at the local, community, basin, and/or regional scale and should be relevant to the core desires, issues, and/or needs of communities, agencies, tribes, and/or other entities that rely on the water resource.

How to meet this criterion? Identify shared water challenges in the catchment or area of interest, through mapping of the project site and conducting desktop research on shared water challenges or engaging with the local community or other entities that rely on or advocate for the water resource. The project objective and activity should relate to a relevant water quality–related shared water challenge.

3. Internal buy-in and general support from external water resource entities

The project has buy-in internally (e.g., within the company), and there is general support for the proposed activity's water quality benefits from external entities that rely on or advocate for the water resource such as communities, agencies, Indigenous Peoples, or other groups.

How to meet this criterion? Conduct community consultation or gather evidence through desktop research before starting a project to confirm relevance for others. The depth of consultation will vary based on the local conditions and may be conducted by implementing partners or entities with local knowledge. If the project is high risk or located in a region with reputational sensitivity, the consultation may warrant additional attention. Identify and understand any concerns and consider the implications (who benefits, what values are supported, etc.). Work with project implementers to minimize trade-offs. Clearly communicate to interested parties the justification for the decision to support an action.

4. Change delivered beyond the without-project condition (change that would not have happened without the activity)

The project delivers positive change and/or prevents a negative impact beyond the without-project condition. Activities that the project sponsor is legally required to conduct to generate a water quality or other water-related benefit for compliance purposes do not qualify for WQBs. However, there are exceptions. If a project sponsor is legally required to contribute funding to environmental efforts through a broader corporate social responsibility program, this money could be directed to a project that provides a WQB if there is additionality and intentionality. Also, there may be situations where the project is legally required by the site owner but there is no available capacity or engagement to implement the activity in a way that would produce a positive change beyond a without-project condition. In this case, a project sponsor could support this activity and consider a generated WQB.

How to meet this criterion? Confirm that the project is not legally required by the project sponsor. Additionally, if the project is legally required by the site owner, document the reasons why compliance would not be possible without support from the project sponsor or why the proposed activity provides value beyond the legal requirement.

5. Established pathway to track project water quality outputs

The project design includes a plan for tracking and reporting after project completion. Include a plan for sustained measures to track whether the project continues to function as designed for the duration of intended WQB claims or, if desired, for the intended lifetime of the project.

How to meet this criterion? Establish a tracking and reporting plan alongside the project implementer during project selection or contracting to ensure that there are resources and capacity to support future project tracking and reporting with clearly identified outputs and outcomes. Both monetary and human resources may be required.

6. Trade-offs assessed, understood, and minimized

The project review should consider trade-offs and potential unintended consequences to ensure that projects are sustainable and minimize adverse and/or unintended outcomes. Review may occur before and/or after project implementation. Examples of potential trade-offs include a decrease in farmer yields with changes in practices, reduced streamflow with use of stormwater capture and storage, or increased reliance on irrigation water to grow cover crops.

How to meet this criterion? Conduct a desktop review, consult others, and/or gather technical evidence before starting a project to identify and understand trade-offs and consider their implications. The depth of this evaluation will vary based on the local conditions. If the project has a high risk of generating adverse outcomes or is in a region with reputational sensitivity, this assessment may warrant additional attention. For large-scale activities that may create complex trade-offs, evaluate and communicate them to appropriate relevant parties prior to implementing the activities. Work with project implementers to minimize trade-offs. Clearly communicate to interested parties the justification for the decision to support an action. Consider additional flexibility for transformational projects that involve large-scale activities where it may be impractical or infeasible to understand all trade-offs.

Appendix B: Project selection considerations

The following considerations can help practitioners identify, prioritize, and select projects that ensure the greatest likelihood of success and contribute to broader social, economic, and environmental outcomes that extend beyond water quality benefits. These considerations are helpful but not required for a project to generate water quality benefits (WQBs). Each consideration is provided below with a definition and description, the value of the consideration, and recommendations for how a practitioner can evaluate an opportunity based on this consideration. Considerations 1–5 capture attributes that contribute to the likelihood of success, and considerations 6–10 capture attributes that provide added impact or value. The considerations are not listed in order of priority, as each company may weigh the importance of these considerations differently.

1. Minimal risk of project failure or underperformance

Consider if the project design is sufficiently robust to generate a WQB over time. Identify potential risks of project failure or underperformance and confirm that measures are in place to address significant risks, including anticipated maintenance or repair needs that may arise.

Why does the consideration matter? Projects with a lower risk of failure, and those with measures in place to provide maintenance and repair, will have a higher probability of providing beneficial outputs and impacts and will allow practitioners to more confidently claim WQBs over time. Additionally, if a project fails and another funding source is needed for repair, then it may be necessary to revisit the attribution of benefits among funders—that is, original WQB claims may be reduced.

How to evaluate an opportunity based on this consideration? Communicate with project implementers to understand project design and assumptions, as well as planned measures for ensuring that the project is sustainable over time.

2. Project implementer readiness and capacity

Evaluate the project implementer's readiness to implement a project based on whether they have an identified vehicle for contracting and receiving funding and can confirm that necessary permits, approvals, and planning steps are underway and achievable. Confirm that the project implementer has the capacity to implement the project successfully in terms of staffing, knowledge, authorization, experience with similar projects, and skills. A history of strong relationships with other practitioners who supported WQB project implementation may be another indication of readiness and capacity.

Why does the consideration matter? A lack of project implementer readiness and capacity to obtain necessary permits and approvals may lead to barriers that prevent or delay project implementation.

How to evaluate an opportunity based on this consideration? Consider and confirm the desired traits and conditions listed above.

3. Clarity on project costs and cost shares among funders

Confirm the total project cost, individual cost components (discovery, design, construction, long-term maintenance, tracking), and individual company contributions to understand if all financing needs are secured, evaluate potential risks of sufficient financing not coming through, and identify the multiple parties involved. Develop an approach for WQB attribution among multiple funding parties. Communicate with the project implementer to understand whether costs may change in the future.

Why does the consideration matter? A lack of clarity on project costs and WQB attribution approach may lead to unanticipated funding gaps, delays in project implementation, or unintended double counting of WQBs. In addition, this information can be used to evaluate the potential for project scaling with additional funding and/or identify potential funding-related dependencies across project phases that may affect delivery of WQBs.

How to evaluate an opportunity based on this consideration? Communicate with project implementers to obtain project cost information and potential funding gaps. Request information on other project sponsors and work with other sponsors to develop a defensible benefit attribution approach.

4. Feasible project implementation timeline

Communicate with the project implementer to ensure that the implementation timeline is known and feasible, particularly when the company intends to use the resulting WQBs to make claims against time-bound goals. This may include both incremental and longer-term progress against goals.

Why does the consideration matter? A lack of clarity on the project implementation timeline and completion of key milestones may increase the likelihood of unanticipated delays in project implementation.

How to evaluate an opportunity based on this consideration? Communicate with project implementers to obtain the project implementation timeline and key milestone information, and to understand risks of implementation delay. Maintain regular communication to ensure progress toward implementation milestones.

5. Anticipated duration of WQBs consistent with desired timeline

The duration of WQBs delivered by projects will vary based on activity type and funding structure. Nature-based solutions and infrastructure projects typically have a long timeline of expected WQBs, whereas projects that involve payment for environmental services or modified agricultural practices may have a shorter (e.g., one-to-three-year) timeline of generating WQBs.

Why does the consideration matter? Projects with an expectation to deliver WQBs for a long time period—for example, 10 or more years—may be desirable for companies with time-bound goals in the future and those that seek to positively impact shared water challenges over a longer duration. Clarity about how long WQBs are expected to be delivered is critical to avoid misunderstandings between the companies investing in a project and project implementers.

How to evaluate an opportunity based on this consideration? Communicate with project implementers to understand the project duration for a given activity and funding structure. Confirm that there is a pathway for reporting at desired frequencies throughout the intended duration of benefit claims. Consider the potential uncertainty of project delivery of the WQB over time in light of climate change and dynamic ecosystem conditions.

6. Location relevant to water goals

Ensure that the project location is relevant to stated water goals. For example, a company's goal may require that the project location have a direct or indirect hydrologic connection to a site's water source or be near the site or local community affected. Alternatively, a goal may require that the project have direct connection to a company's value chain—that is, its consumer base or supply chain.

Why does the consideration matter? Water is local, and goals should be contextual based on local conditions. Projects with relevance to stated water goals will be required to make defensible claims of WQBs against these goals.

How to evaluate an opportunity based on this consideration? Conduct a desktop review of project attributes in the context of corporate water stewardship goals.

7. Opportunity to deliver multiple benefits

Consider whether the project has the potential to generate benefits beyond water quality and the opportunity to deliver on other company goals related to water availability; water access, sanitation, and hygiene (WASH); as well as carbon, biodiversity, social, or economic impacts. Note that additional tracking may be needed to report these multiple benefits.

Why does the consideration matter? Projects that provide benefits in addition to WQBs will support shared water challenges in a more holistic way and may be more relevant to entities that rely on or advocate for the water resource. Some companies are setting goals that go beyond water quality benefits, and projects with multiple benefits may help meet those goals.

How to evaluate an opportunity based on this consideration? At the start of the project, communicate with project implementers to understand its potential multiple benefits. Project implementers should document the without-project condition and may need to expand monitoring for additional multibenefits. Document the additional benefits qualitatively. If possible, use available methodologies to quantify the additional benefits (see Box B-1).

8. Enabling projects

Enabling projects may catalyze actions with larger overall potential for impact. These projects may be critical stepping stones for larger-scale efforts that are transformational and provide larger impacts to address shared water challenges. They may also provide opportunities to positively influence water governance. These projects may include early-phase activities, such as planning, design, permitting, or pilots, that set the stage for additional, larger-scale work to be implemented.

Box B-1 | Quantifying multiple benefits

Additional resources are available to support quantification of multiple benefits, including the CEO Water Mandate's *Benefit Accounting of Nature-Based Solutions for Watersheds* (Brill et al. 2021), Wash4Work's *WASH Benefits Accounting Framework* (Jacobson et al. 2024), and guidance on Volumetric Water Benefit Accounting 2.0 led by WRI, LimnoTech, Bluerisk, and Bonneville Environmental Foundation (2025).

Why does the consideration matter? There is a need and opportunity for corporations to support larger-scale efforts that are transformational and generate significant impacts to address shared water challenges. Many of these opportunities require an early-stage enabling investment to break down barriers and open pathways for larger-scale implementation. Additionally, enabling projects may be important in regions where few other water stewardship efforts currently exist.

How to evaluate an opportunity based on this consideration? Communicate with the project implementer to evaluate whether there are opportunities for enabling, replicable, or scalable projects.

9. Innovative strategies

Projects that generate WQBs but also incorporate innovative strategies related to financing, technology, and/or market systems may be considered with higher priority. Financing schemes that are sustainable, leveraged, and/or have the potential to unlock additional funding may offer new pathways to generate WQBs, increase scalability, and/or deliver higher impact. Pilot implementation of innovative technologies may lead to market-driven deployment of new solutions and/or provide a favorable investment structure for an expanded range of project sponsors.

Why does the consideration matter? There is a need to expedite and unlock funding opportunities for corporations to catalyze larger-scale efforts that are transformational and generate significant impacts to address shared water challenges.

How to evaluate an opportunity based on this consideration? Consider project opportunities with innovative finance and investment schemes (e.g., investment funds, microloans, revolving funds, repayments funneled back to project maintenance, projects that improve the policy landscape) innovative technologies, and/or market systems.

10. Opportunity for collaboration

Projects that generate WQBs but also provide opportunities for collaboration through collective funding and collective action (i.e., co-designing, co-funding a project) may be considered with higher priority. Projects that include collaboration with multiple corporate funders and on-the-ground implementers deliver value in terms of greater impact, transparency, and storytelling. Collective action may allow a company to contribute to a broader suite of projects, resulting in increased engagement and a higher profile.

Why does the consideration matter? There is a need to expedite the implementation of larger-scale activities that provide basin-scale benefits. There is strength in numbers. With collaboration, more impact can be realized at a larger scale.

How to evaluate an opportunity based on this consideration? Consider project opportunities that involve collaboration. Join or help establish regional collective action groups to help identify and support project opportunities.

Appendix C: Guidance for indicator and method selection

Table C-1 | **Overview of recommended WQB calculation methods for common water stewardship activities and pollutants**

METHOD (APPENDIX D SECTION)	METHOD DESCRIPTION	MOST APPROPRIATE APPLICATIONS	SEDIMENT	NUTRIENTS	BACTERIA	TEMPERATURE	METALS
Pollutant Reduction Efficiency method (D-1)	Used to estimate reduced pollutant loading by determining a representative unit area loading (UAL) rate for the contributing drainage area under consideration and a percent reduction factor by which that pollutant load is reduced after the activity is implemented.	Broadly applicable to different locations, activity types, and pollutants in situations where defensible, location-specific UALs and pollutant- and activity-specific removal efficiencies are available.	X	X	X		X
Simple Method (D-2)	Applies runoff coefficients specific to certain land types and pollutant-specific event mean concentrations to estimate improvements after a change is made.	Urban runoff or stormwater projects involving land use, land cover, or imperviousness change.	X	X	X		X
Universal Soil Loss Equation method (D-3)	An empirical model for estimating soil erosion as a function of rainfall and runoff erosivity, soil erodibility, slope length, slope steepness, cover factor, and a conservation practice factor.	Agricultural or land restoration activities where soil erosion or sediment-bound pollutants are an issue, and typically for relatively smaller-scale projects.	X	X			
Treatment System method (D-4)	Applies mass balance principles to estimate pollutant load reductions or percent concentration reductions achieved between the inlet and outlet of the system.	Intercepting treatment best management practices designed and installed with a primary purpose of improving water quality.	X	X	X	X	X
Water Quality Monitoring method (D-5)	Involves development and implementation of a monitoring program to measure flow and/or pollutant concentrations at the inlet and outlet of a structural practice or in the receiving water body impacted by large-scale implementation activities. Typically not applicable if potential future WQBs are being estimated.	Clearly defined inlet and outlet, or large-scale projects (thousands of hectares), a regulatory endpoint, or need to demonstrate meeting a water quality standard.	X	X	X	X	X
Modeling method (D-6)	Use of simple modeling approaches or mechanistic field- or watershed-scale models applied to agricultural, urban, or other landscape settings.	Large-scale projects (thousands of hectares), when existing models are readily available, or when required by the local program (e.g., WQ trading).	X	X	X	X	X
Region-specific methods (D-7)	Involves the use of a credible and established tool or model that is locally adopted for the purpose of estimating WQBs relevant to the pollution problem.	When required by a local or regional program such as water quality trading, TMDL, grant funds, stormwater management, and so on.	X	X	X	X	X

Notes: TDML = total maximum daily load; WQ = water quality; WQB = water quality benefit.
Source: Authors.

Table C-2 | **Applicable pollutants, indicators, and WQB calculation methods for common water stewardship activities**

CATEGORY	ACTIVITY	APPLICABLE POLLUTANTS					APPLICABLE INDICATORS				APPLICABLE METHODS (APPENDIX D SECTION)
		Sediment	Nutrients	Bacteria	Metals	Temp.	Reduced load	Avoided load	Conc. reduction	Average or peak temp.	
Agricultural (field management)	Cover crops	X	X	X			X		X		D-1, D-2, D-3, D-6, D-7
	Conservation crop rotation	X	X	X			X		X		D-1, D-2, D-3, D-6, D-7
	Agroforestry	X	X	X		X	X		X	X	D-1, D-2, D-3, D-6, D-7
	No-till or conservation tillage (mulching or mulch tillage)	X	X	X			X		X		D-1, D-2, D-3, D-6, D-7
	Nutrient management (fertilizer and manure)		X	X			X		X		D-1, D-6, D-7
	Irrigation efficiency	X	X				X		X		D-1, D-3, D-6, D-7
	Contour planting	X	X	X			X		X		D-1, D-3, D-6, D-7
Agricultural (structural)	Terracing	X	X	X			X		X		D-1, D-3, D-6, D-7
	Edge-of-field windbreaks, vegetated buffers, filter strips, prairie strips, stream setbacks	X	X	X		X	X		X	X	D-1, D-6, D-7
	Filtration devices (bioreactors, phosphorus-sorbing materials)	X	X	X	X		X		X		D-1, D-4, D-5, D-6, D-7
	Grassed waterways	X	X	X			X		X		D-1, D-6, D-7
	Drainage water management		X				X		X		D-1, D-2, D-4, D-5, D-6, D-7
Urban	Stormwater capture or treatment systems *with* well-defined inlets and outlets	X	X	X	X	X	X		X	X	D-1, D-4, D-5, D-6, D-7
	Stormwater capture or treatment systems *without* well-defined inlets and outlets	X	X	X	X	X	X		X	X	D-1, D-2, D-6, D-7
	Wastewater treatment system construction or enhancement	X	X	X	X	X	X		X	X	D-1, D-4, D-5, D-6, D-7
Legacy contaminants	Contaminated site cleanup or treatment systems	X	X	X	X		X		X		D-1, D-4, D-5, D-6, D-7
Sanitation	Improved sanitation facilities		X	X	X		X		X		D-1, D-4, D-5, D-6, D-7

Table C-2 | **Applicable pollutants, indicators, and WQB calculation methods for common water stewardship activities (cont.)**

CATEGORY	ACTIVITY	APPLICABLE POLLUTANTS					APPLICABLE INDICATORS				APPLICABLE METHODS (APPENDIX D SECTION)
		Sediment	Nutrients	Bacteria	Metals	Temp.	Reduced load	Avoided load	Conc. reduction	Average or peak temp.	
Natural landscapes and rangelands	Groundwater recharge basin	X	X	X		X	X		X	X	D-1, D-6, D-7
	Wetland creation or restoration	X	X	X	X	X	X		X	X	D-1, D-4, D-5, D-6, D-7
	Land conservation or protection, avoided habitat degradation	X	X	X	X			X			D-1, D-2, D-3, D-6, D-7
	Restoration of native vegetation	X	X	X	X	X	X		X	X	D-1, D-2, D-3, D-6, D-7
	Sustainable grazing	X	X	X			X		X		D-1, D-2, D-3, D-6, D-7
	Fire management	X	X		X		X		X		D-1, D-3, D-6, D-7

Source: Compiled by authors. Based on Reig et al. 2019 and Brill et al. 2021.

Appendix D: Water quality benefit calculation methods

Sections D-1 through D-7 describe methods available to guide calculation of water quality benefits (WQBs) for common water stewardship project activities, pollutants, and indicators. Although the methods described range in complexity, some technical expertise is required to apply even the simplest methods. Many of them represent some form of model-based estimation techniques. While Sections D-1, D-2, and D-3 outline specific model-based approaches, the methods described in Sections D-6 and D-7 represent broader but distinguishable categories of model-based techniques. Appendix C and the introductory text to each method provide some guidance on selecting among the different modeling-based approaches. These sections are not designed to provide a detailed and prescriptive "how to" manual for quantifying WQBs or a user guide for the modeling approaches. Practitioners should view this information as general guidance to inform the quantification process.

The general form of each WQB calculation method involves computing the difference between the with- and without-project conditions, and the benefit is expressed either as an absolute pollutant load change or a relative pollutant load change (i.e., a percentage difference). Although WQBs are typically calculated on an annualized basis, there may be situations where different temporal scales are applied, such as projects addressing seasonal water quality impacts.

D-1. Pollutant Reduction Efficiency method

Methodology description

This method involves estimating a reduced pollutant loading by determining a representative unit area loading (UAL) rate for the contributing drainage area under consideration and a percent reduction factor by which that pollutant load is reduced after the activity is implemented. It can be used to estimate WQBs for a large variety of geographic locations, activity types, and pollutants; however, this method is most appropriate in situations where defensible, location-specific UALs and pollutant- and activity-specific removal efficiencies are available.

Activities, pollutants, and indicators

The Pollutant Reduction Efficiency method is a broadly applicable approach to estimating the WQBs from different activities across diverse landscapes and for many types of pollutants. Although it typically applies to activities that intercept runoff, it may also be used for activities applied in the entire contributing area impacted, such as green roofs in urban settings or fertilizer management and conservation tillage in agricultural landscapes. Reduced pollutant loading is the indicator associated with this method.

Required inputs

Three basic inputs are required for the Pollutant Reduction Efficiency method: the size of the contributing drainage area impacted by the stewardship activity (e.g., in acres or hectares); the long-term, average annual pollutant UAL appropriate for that contributing drainage area (e.g., lbs/acre/year or kg/ha/year); and the average annual percent load reduction (%) specific to the pollutant of concern and activity being implemented. The WQB is expressed as a reduced pollutant loading using the following equation:

WQB = reduced load = UAL * area * % reduction

An alternative form of the Pollutant Reduction Efficiency method can be used for project activities where both a with- and a without-project UAL can be defined, such as those involving changes in land cover. In these instances, the WQB is expressed as a reduced pollutant loading using the following equation:

WQB = reduced load = area * (UAL $_{pre}$ **– UAL** $_{post}$**)**

Also referred to as export coefficients (ECs), the UAL should represent the long-term, annual average pollutant loading, typically from a single land use, such as row crop agriculture. The use of UALs intentionally seeks to account for year-to-year loading variability caused by numerous factors (e.g., the precipitation amounts and intensity) to simplify the calculation of loading estimates. It is ultimately the responsibility of the practitioner calculating WQBs by this method to determine appropriate and technically defensible UALs for the project being evaluated. Criteria that should be considered when making this determination include UALs that represent the geographic location of interest; the pollutant(s) of interest, including consideration of total versus dissolved forms; the climate and runoff characteristics; the soil and topographic characteristics of the contributing area; and the land cover, use, and management characteristics (e.g., cropping system, tillage, and fertilization for agricultural lands). Various resources in the peer-reviewed literature and other documents can inform UALs, including foundational work by Beaulac and Reckhow (1982), more recent monitoring- and modeling-based studies (Anning et al. 2014; Flynn et al. 2017; Harmel et al. 2022; McDowell et al. 2021; Robertson et al. 2014; Robertson and Saad 2019; Saad et al. 2019; White et al. 2015), and life-cycle impact assessments. These example resources are by no means comprehensive but rather represent the types of studies that can be used to inform UALs or ECs when the Pollutant Reduction Efficiency method is selected.

Percent reduction factors should also be representative of long-term, annual average expected performance specific to a certain pollutant and activity type. Pollutant reduction efficiency varies as a function of storm event size and intensity, the size of the project activity, the type of pollutant, and several other factors. Selection of appropriate values should consider this variability and strive to represent load-reduction efficiency over the long term. Such values may be determined from local guidelines, professional standards, published literature, or site-specific monitoring. Resources that might be consulted for understanding ranges of pollutant removal efficiencies include CBP 2018, Clary et al. 2020, RESPEC 2017, and Stack et al. 2018. As for UALs, responsibility for selecting appropriate and defensible pollutant reduction efficiencies falls to the WQBA practitioner and cannot be easily prescribed, as each situation is unique.

Caveats, assumptions, and other considerations

As emphasized above, it is important that the practitioner use good professional judgment and decision-making regarding selection of appropriate UALs and percent reduction factors based on the specifications of the activity (geography, land use, expected benefits and impacts, size of the best management practice [BMP], etc.). As an example, the practitioner should ensure that structural practices are sized appropriately relative to the anticipated runoff and pollutant loading for the reduction efficiency to be confidently applied. For example, although a 50 percent load reduction may be determined for a constructed treatment wetland intercepting urban runoff, if that wetland is grossly undersized it will likely have a much lower reduction efficiency, while a wetland that is oversized may realize higher reduction efficiencies. The practitioner should ensure that the design and construction of the structural practice meets required specifications for performance. If such confirmation cannot be made when collecting data and information to evaluate the project, then the practitioner should caveat the WQB results with the assumption that the BMP was sized appropriately for the volume to be treated and recommend on-the-ground confirmation that the construction met those specifications.

Although this method is relatively simple to apply, with the lower level of rigor and data collection comes a greater amount of uncertainty. If a more refined estimate of the WQB is desired, then alternative methods such as monitoring or mechanistic modeling should be considered.

Example applications of the Pollutant Reduction Efficiency method are provided in Tables D1.1 and D1.2.

Table D1.1 | **Illustrative example 1 of how to apply the Pollutant Reduction Efficiency method**

CASE STUDY	FOREST RESTORATION
Activity	Restoration of post-wildfire forest through brush and debris removal, tree plantings, and reduction of undesirable competing plants.
Shared water challenges addressed	Increased post-wildfire soil erosion and sediment delivery to downstream water bodies.
Project description	The project has three main activities focused on the restoration of 80 acres of forest impacted by the 2013 Rim Fire in California. Activities will include the felling and piling of dead trees and the removal of competing live brush across the site to reduce the availability of fire fuel and prepare the site for tree planting, planting approximately 16,000 one-year-old seedlings on 80 acres where natural regeneration has not occurred, and applying targeted herbicide treatments over a two-year period following the planting to reduce competition to planted seedlings from undesired plant species.
Location	Tuolumne River Watershed, California, United States
Project start date	2022
Project end date	2024
Without-project condition	The project area was currently dominated by brush, with a scattered overstory of trees. The area is impaired by fire, with pockets of heavy down fuel scattered throughout the unit, along with small patches and scattered individual standing dead trees.

Table D1.1 | **Illustrative example 1 of how to apply the Pollutant Reduction Efficiency method (cont.)**

CASE STUDY	FOREST RESTORATION
With-project condition	The project area has a desired future condition of an open canopy mosaic with fire and drought-tolerant trees with 40–50% canopy cover, averaging 257 trees per acre in clumps of four.
WQB indicator	Reduced sediment load
WQB indicator calculations	The difference in sediment load between the current (without-project) and restored (with-project) conditions was calculated using the Pollutant Reduction Efficiency method. Unit area loading rates for sediment were determined for the Sierra Nevada ecoregion from a reputable literature reference (White et al. 2015). A UAL for grassland was selected for representing the without-project condition (brush with limited tree overstory) and a UAL for forest for the with-project condition. WQB = reduced sediment load = without-project sediment load – with-project sediment load WQB = (project area) × [(without-project UAL) – (with-project UAL)] = (32.4 ha) x [(0.82 MT/ha/year) – (0.2 MT/ha/year)] = **20.1 MT/year** The corporation's share of 100% of the total project cost would be applied to this total WQB.
Complementary indicator	Volumetric benefits: The volumetric water benefit is based on reduced runoff from the project area, calculated using the Curve Number method. The volumetric water benefit calculated was 4.8 million gallons per year.
Comments	To ensure reasonableness of results, a variety of sources were consulted for the with- and without-project unit area load to arrive at a reasonable, conservative estimate of reduced sediment load, including a research study specific to the 2013 Rim Fire. After reviewing post-wildfire sediment UALs from that study, it was determined that the characteristics of that landscape studied were not consistent with aerial imagery and site descriptions from the project partner of the restoration site. Furthermore, it was decided that using values within a single study would help ensure consistency in methods that might provide a more realistic representation of variability in UAL between land cover conditions before and after project implementation.
Considerations	With an expected water quality water benefit duration of 10 years and the year of initial claim expected in 2023, water quality benefits may be counted through the end of 2032, provided there is annual evidence the project is functioning as intended. The water quality benefit represents a fully mature tree condition. Typically, companies claim reforestation project benefits that are consistent with this assumption, even though in reality it will take years of growth before this occurs. If desired, the company could claim an incrementally increasing benefit consistent with tree maturity.

Notes: ha = hectare; MT = metric tons; UAL = unit area load; WQB = water quality benefit.

Source: Authors.

Table D1.2 | **Illustrative example 2 of how to apply the Pollutant Reduction Efficiency method**

CASE STUDY	AGRICULTURAL BEST MANAGEMENT PRACTICES
Activity	Adoption of regenerative agricultural practices to reduce nutrient runoff
Shared water challenge(s) addressed	Water quality (nutrient pollution)
Project description	The company in the food and beverage agricultural sector invests in adopting regenerative agricultural practices such as no-till, reduced till, and cover crops to reduce nutrient loading to the Gulf of Mexico.
Location	Mississippi River basin, United States
Project start date	2021
Project end date	n/a, ongoing practice changes
Without-project condition	Full tillage, no cover crops
With-project condition	Reduced/no-till, cover crops
WQB indicator	Nutrient load reduced
WQB indicator calculations	WQB = UAL * area * % reduction
Complementary indicator	VWB, carbon reductions and removals
Comments	There is enough methodological variation that conservative estimates are preferred when possible. Based on the array of UALs from different regions, the company created a maximum UAL to cap the impact factor and keep estimates conservative. This may not be necessary as the WQB estimation space matures. The company also used different approaches to quantify benefits before settling on the selected approach. Different calculation approaches delivering a similar order of magnitude of benefits is valuable for consistent results. When presented with multiple approaches to calculate the same WQB, the company's main criteria are the conservativeness of the quantification approach and external experts' view of the robustness of the quantification approach.
Considerations	Regenerative agriculture is an activity with multiple water quality benefits: nitrogen, phosphorus, sediment, etc. The company only counts one type of water quality benefit, expressed as N-equivalent. The water quality benefit selected should be most aligned to the problem the activity is trying to address. For the Mississippi River basin, nitrogen loading would be the preferred metric; however, if there are WQB data for phosphorus but not nitrogen, a phosphorus WQB may be generated and translated to N-equivalent for the purposes of standardized tracking and reporting.

Notes: N = nitrogen; n/a = not applicable; UAL = unit area load; VWB = volumetric water benefit; WQB = water quality benefit.
Source: Authors.

D-2. Simple Method

Methodology description

The Simple Method is an approach to estimate pollutant loading by multiplying annual runoff volumes by land use-specific pollutant concentrations, sometimes referred to as event mean concentrations (EMCs) (Schueler 1987). Although this method is typically used for stormwater runoff from urban areas, it can be more broadly applied to a variety of land uses or soil conditions to estimate loading reductions so long as a change in runoff and/or change in pollutant concentration can be estimated for the restored condition.

Activities, pollutants, and indicators

Although the Simple Method can apply broadly to any activity where both a change in runoff and change in average pollutant concentration can be quantified or estimated, it is best suited for activities involving a meaningful change in the land cover or preservation of an existing natural land cover from conversion to another land cover that is expected to produce more runoff and higher pollutant loading. Most often this method applies to activities involving nonagricultural areas (e.g., urban or developed land uses). The indicators corresponding to this method are reduced pollutant load or avoided pollutant load. It is not specific to a certain subset of pollutants but instead can be used to estimate water quality benefits (WQBs) for any pollutant for which EMCs are available (i.e., through direct measurement in representative nearby land uses or literature-based values appropriate for that area).

Required inputs

The pollutant load is computed using the following equations and inputs:

L = conversion factors * C * A * P * P_j * $R_{v\text{-composite}}$

$R_{v\text{-composite}} = (R_{vI} * \%I) + (R_{vMT} * \%MT) + (R_{vMO} * \%MO) + (R_{vF} * \%F)$

- L = pollutant load
- Conversion factors
  - For C expressed in mg/L and L in lbs/year, use 2.2266×10^{-1}.
  - For C expressed in µg/L and L in lbs/year, use 2.2266×10^{-4}.
  - For C expressed in colonies/100 mL (e.g., bacteria) and L in colonies/year, use 1.0282×10^{6}.
  - Alternative conversion factors are needed if different input and/or output units are used.
- C = event mean concentration (EMC)
- A = contributing area being evaluated (acres)
- P = average annual precipitation depth (inches)
- P_j = fraction of precipitation events that produce runoff (often assume 0.9)
- $R_{v\text{-composite}}$ = composite volumetric runoff coefficient
  - R_{vI} = runoff coefficient for impervious cover
  - R_{vMT} = runoff coefficient for managed turf (lawns, road rights-of-way, etc.)
  - R_{vMO} = runoff coefficient for mixed open space (meadow, pastureland)
  - R_{vF} = runoff coefficient for forest/open space
- %I = percent of the contributing area that is impervious cover
- %MT = percent of the contributing area that is managed turf
- %MO = percent of the contributing area that is mixed open space
- %F = percent of the contributing area that is forest

An alternative approach to computing the runoff coefficient uses a regression-based equation developed from monitoring data for small urban catchments throughout the United States (Schueler 1987):

$R_v = 0.05 + (0.9 * I_a)$

Where I_a is the watershed imperviousness expressed as a percentage.

When applying this method, practitioners should select appropriate inputs for the location of interest. Average annual precipitation can be obtained from a variety of resources. The contributing area and its breakdown into different land cover types can be determined from analysis of geospatial data. EMCs should be based on research or monitoring conducted in the area, or from literature sources. Example compilations of EMCs for a variety of pollutants, geographies, and land uses include Smullen and Cave 1998, Lin 2004, Stein et al. 2008, and Pitt et al. 2018. Local resources may also be used to determine appropriate runoff coefficients by land use or alternative methods. For example, the State of Virginia adopted runoff coefficients as a function of hydrologic soil group (HSG) and land cover, as shown in Table D2.1 (CWP and CSN 2008; VDEQ 2024).

The water quality benefit is computed as the load reduction between the baseline, or without-project condition, and the future or with-project condition as

WQB = reduced pollutant load = $L_{pre} - L_{post}$

If the Simple Method is used to estimate a water quality benefit as an avoided pollutant load, then the equation takes a slightly different form, where the first term is a future degraded state and the second term is the current desirable state.

WQB = avoided pollutant load = $L_{degraded} - L_{current}$

Table D2.1 | **Land cover volumetric runoff coefficients (Rv)**

	RUNOFF COEFFICIENTS			
Hydrologic soil group[a]	HSG-A	HSG-B	HSG-C	HSG-D
Forest	0.02	0.03	0.04	0.05
Mixed open space	0.08	0.11	0.13	0.15
Managed turf	0.15	0.20	0.22	0.25
Impervious cover	0.95			

Note: HSG = hydrologic soil group; [a] Hydrologic soil groups A, B, C, and D correspond to low, moderately low, moderately high, and high runoff potential, respectively.

Source: VDEQ 2024.

Applications

The Simple Method is typically used for urban runoff evaluations but can be applied to any land cover types. The method is most effective when representative runoff coefficients can be determined, often as a function of land use and soil characteristics as described earlier in this section. The Simple Method can be used for any pollutant for which an annualized event mean concentration (EMC) can be confidently defined. This method has been accepted and/or applied throughout the United States, including in Virginia (VDEQ 2024), Texas (Landphair et al. 2000), Minnesota (Weiss et al. 2005), and California (Garrison et al. 2014).

Hypothetical example

A freshwater lake in an urban setting is impaired because of elevated copper concentrations resulting in aquatic toxicity. Excess copper loading from the lake's watershed is the cause, and urban stormwater runoff is known to be a primary source. A landscape restoration project was completed on 100 acres of mixed urban land use to reduce stormwater runoff volumes and copper loading to the lake. The project involved conversion of certain impervious surfaces (abandoned parking lots) and manicured lawns (turf) to native meadows (mixed open) and forests. The without-project land composition is 20 percent impervious, 60 percent managed turf, 15 percent mixed open, and 5 percent forest. The with-project land composition is 10 percent impervious, 30 percent managed turf, 50 percent mixed open, and 10 percent forest. The HSG is C for the project area, which receives an average precipitation of 40 inches per year, and the fraction of events that produce runoff is 0.90. A copper EMC of 15 μg/L was applied for both without- and with-project conditions. This conservative assumption suggests that the copper load reduction is achieved through the reduction of stormwater runoff volumes. The WQB for this project was computed using the Simple Method as the copper load reduction resulting from the urban land restoration activities:

$$WQB = L_{pre} - L_{post}$$

$$L = 2.266 \times 10^{-4} * C * A * P * P_j * R_{v\text{-composite}}$$

$$R_{v\text{-composite}} = [(R_{v\text{-I}} * \%I) + (R_{v\text{-MT}} * \%MT) + (R_{v\text{-MO}} * \%MO) + (R_{v\text{-F}} * \%F)] / 100\%$$

$$R_{v\text{-composite-pre}} = [(0.95*20\%) + (0.22*60\%) + (0.13*15\%) + (0.04*5\%)] / 100\% = 0.34$$

$$L_{pre} = 2.266 \text{ x } 10^{-4} * 15 \text{ ug-Cu/L} * 100 \text{ acres} * 40 \text{ in/yr} * 0.90 * 0.34 = 4.16 \text{ lbs-Cu/year}$$

$$R_{v\text{-composite-post}} = [(0.95*10\%) + (0.22*30\%) + (0.13*50\%) + (0.04*10\%)] / 100\% = 0.23$$

$$L_{post} = 2.266 \text{ x } 10^{-4} * 15 \text{ ug-Cu/L} * 100 \text{ acres} * 40 \text{ in/yr} * 0.90 * 0.23 = 2.81 \text{ lbs-Cu/year}$$

$$WQB = L_{pre} - L_{post} = 4.16 - 2.81 \text{ lbs-Cu/year} = 1.35 \text{ lbs-Cu/year}$$

Caveats, assumptions, and other considerations

The Simple Method provides an alternative method to the Curve Number (CN) method for generating annual runoff volumes. If practitioners are using the CN method to estimate the VWB and the Simple Method to estimate the WQB, runoff volume estimates should be compared and evaluated for consistency, and, if necessary, any reasons for differences should be reconciled.

The Simple Method does not estimate pollutant loads associated with baseflow, and therefore alternative methods should be used for projects that impact both surface runoff and subsurface flow pathways. Additionally, the Simple Method was developed and intended for relatively small watersheds (e.g., tens to hundreds of acres). It should not be applied to projects involving larger watersheds with complex land use and soil characteristics.

D-3. Universal Soil Loss Equation (USLE) method

Methodology description

The Universal Soil Loss Equation (USLE) is an empirical model for estimating soil erosion with a history dating back to small plot studies in the 1930s (Wischmeier and Smith 1965). The model has been enhanced over the last half-century and used in different implementations, such as the Modified Universal Soil Loss Equation (MUSLE), the Revised Universal Soil Loss Equation (RUSLE), and the Hydrogeomorphic Universal Soil Loss Equation. As described below, the USLE and its variants are well suited to quantify sediment and sediment-associated pollutant loads. However, these methods are not suitable for addressing pollutants that do not strongly associate with sediments (e.g., nitrate, ammonium, certain pesticides).

Activities, pollutants, and indicators

Although the USLE is typically used to estimate the benefits of adopting structural and nonstructural agricultural conservation practices, it can also be used for land conservation or restoration activities such as grassland preservation, sustainable grazing on rangeland, and reforestation. Common agricultural activities for which the USLE is well suited to estimate water quality benefits (WQBs) include improvements in tillage (reduced tillage, conservation tillage, strip till, or no-till), diversifying crop rotations, use of cover crops or perennial vegetation, and introduction of strip cropping, contouring, or terracing structures.

The USLE itself only estimates sediment loading from soil erosion, but load estimates for any sediment-bound pollutant can be made by multiplying by soil-associated concentrations (i.e., mass pollutant per mass soil) (Brill et al. 2021). Also called sediment-associated pollutant concentrations, particulate concentrations, or sediment potency factors, these values can be determined from local or regional monitoring datasets, local guidelines or guidance documents, or national guidance documents (US EPA 1985). In some cases, pollutant concentration estimates are embedded within tools or models that rely on the USLE (MDEQ 1999). The five major types of pollutants that tend to strongly associate with sediments include nutrients (phosphorus, nitrogen), bulk organics (oils, grease), persistent organics (DDT, PCBs), polycyclic aromatic hydrocarbons, and metals (iron, lead, mercury, etc.) (US EPA 2012).

The most common water quality indicator associated with this method is reduced pollutant load (for sediment and sediment-bound pollutants). Avoided pollutant load may also be an appropriate indicator generated by the USLE method for land preservation or conservation activities.

Required inputs

The basic form of the USLE uses the following equation:

$A = R * K * L * S * C * P$

where A = average soil loss (mass per unit area per year), R = rainfall and runoff erosivity index, K = soil erodibility factor, L = slope length factor, S = slope steepness factor, C = cover management factor, and P = conservation practice factor (USDA ARS 2013).

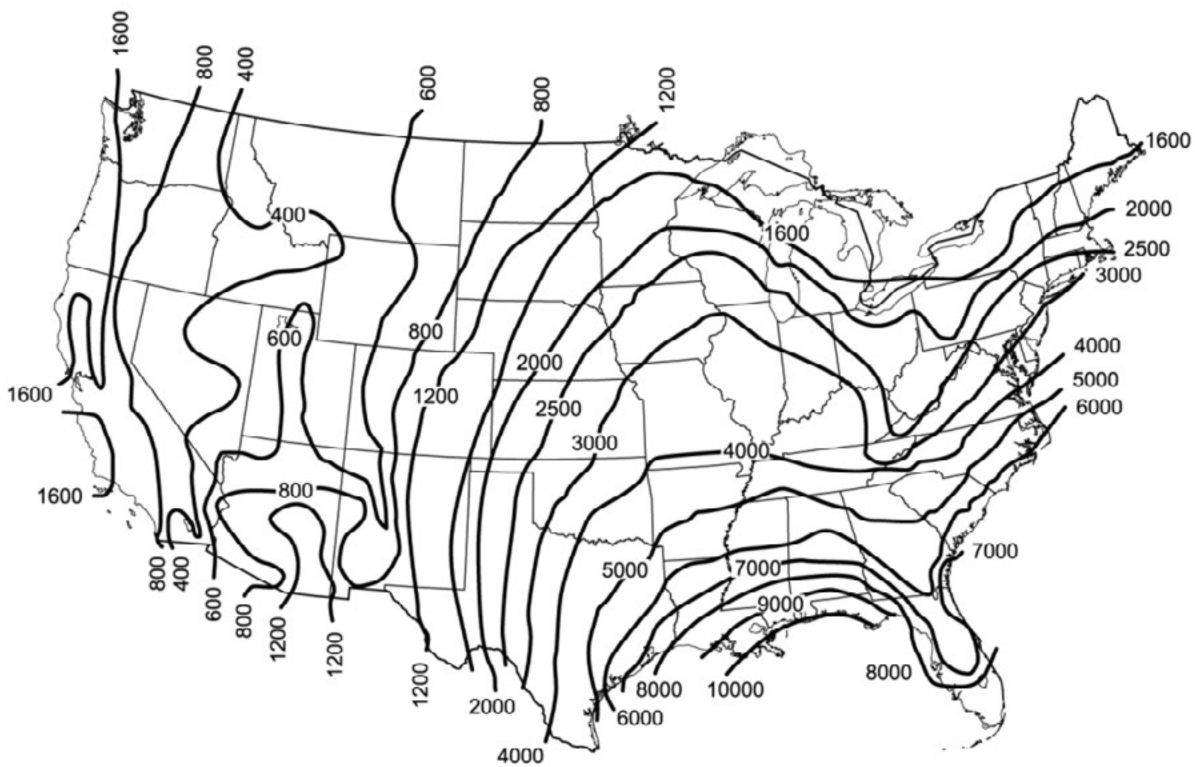
Each of these inputs to the basic USLE can be determined from several approaches and should be chosen by the practitioner based on their judgment and experience in using the USLE, whether as a stand-alone calculation or part of another tool or model. Practitioners should reference publications such as user manuals, textbooks, professional standards, or peer-reviewed literature to support the input selection process. Rainfall and runoff erosivity index (R factor) values can be determined from iso-erodent maps or lookup tables based on geographic location (Figure D3.1; Huffman et al. 2013; Panagos et al. 2015; OMAFRA 2023). Soil erodibility (K factor) can be determined from lookup tables based on location, soil type, organic matter, and soil texture, or from regression equations that account for soil transport properties and soil runoff and detachment potential (Huffman et al. 2013). The slope length (L factor) and steepness (S factor) terms can be determined from separate equations or determined from charts. The cover management (C factor) values can be used to account for the effects of crop and residue-related cover, tillage, field productivity, and length of the growing season, and is estimated from lookup tables or programs like the RUSLE2 (Huffman et al. 2013). The conservation practice (P factor) values are used to inform reduced sediment erosion resulting from field-scale implementation of contouring, terracing, or strip cropping practices (Stewart et al. 1975).

When sediment load reduction is selected as the appropriate indicator to estimate the WQB of an agricultural conservation activity or land cover restoration activity, the following equation applies:

$WQB = \text{reduced sediment load} = A_{pre} - A_{post} = (R\ K_{pre}\ L\ S\ C_{pre}\ P_{pre}) - (R\ K_{post}\ L\ S\ C_{post}\ P_{post})$

As suggested by the above equation, the R, L, and S factors are unlikely to change as a result of a conservation activity (i.e., the annual rainfall and slope characteristics for the geographic location and contributing area are typically constant). The soil erodibility factor (K) is also typically fixed (i.e., the soil properties do not change), but it may be appropriate to adjust the K factor as a result of higher soil organic matter associated with the activity, especially if confirmed by long-term soil monitoring. The cover

Figure D3.1 | **Iso-erodent map of rainfall and runoff erosivity factors (R-factors) for the continental United States**



Note: In units of (megajoules · millimeters) / (hectare · hour · year). Unit conversions may be necessary.
Sources: Adapted from Foster et al. 1981, as presented in Huffman et al. 2013.

management factor (C) and support practice factor (P) are the USLE terms most likely to be impacted by conservation activities.

When sediment-bound pollutant load reductions are selected as the WQB indicator, the following equation applies:

WQB = reduced sediment-bound pollutant load = $(A_{pre}\ PF_{pre}) - (A_{post}\ PF_{pre})$

where PF is the potency factor (often expressed in mg/kg or lbs/ton), the numerator is the mass of sediment-bound pollutant, and the denominator is the mass of sediment. Unit conversions are also likely needed depending on the unit system used to estimate the soil erosion term (A). Although the PF term is typically an inherent property of the soil local to the contributing area and therefore is unlikely to be significantly changed by the activity (i.e., the benefit is realized by reducing sediment loading, not by reducing the potency factor of the sediment-associated pollutant). There may be certain situations where it is appropriate to also reduce the potency factor after project implementation.

When sediment load avoided or sediment-bound pollutant load avoided is selected as the WQB indicator, the same above equations and recommendations for variable versus fixed or constant terms generally apply. However, in this case, the current condition represents the desirable state and the "without-project" condition represents a future degraded condition expected if the land were not put into conservation/preservation:

WQB = avoided sediment load = $A_{degraded} - A_{current}$

WQB = avoided sediment-bound pollutant load = $(A_{degraded}\ PF_{degraded}) - (A_{current}\ PF_{current})$

Applications

The current stand-alone implementation of the USLE supported by USDA ARS is RUSLE2, a computer simulation software version of the model that is highly flexible and can represent a variety of geographic areas (USDA ARS 2013). The USLE has also been incorporated into relatively simpler models like the US EPA Region 5 Model, STEPL, PLET, and GWLF, as well as more complex mechanistic models such as the Soil and Water Assessment Tool (SWAT) and AnnAGNPS. Although a typical application of the USLE involves estimating the impacts of conservation activities at the field scale (e.g., tens to hundreds of hectares), it can be scaled up to represent larger subwatershed areas, especially when the USLE is exercised within mechanistic watershed models like AnnAGNPS and SWAT.

Caveats, assumptions, and other considerations

Care must be taken when applying the USLE, either as a stand-alone simulation using RUSLE2 or when embedded in simple tools or complex models, to ensure that the resulting WQBs are reasonable and supported by on-the-ground confirmation that project activities have been implemented successfully. Due to the sensitivity of the USLE equation to various input coefficients, experience suggests that the USLE may overstate the magnitude of sediment loading in both baseline and with-project conditions (for example, in areas of high rainfall or runoff, high slopes, or low ground cover) relative to typical sediment unit area loading rates or monitoring-based estimates of sediment loading in riverine systems. This method may also overstate the benefits of conservation activities if the practitioner specifies significant changes in K, C, or P factors for with-project conditions.

Care should be taken when applying the USLE method to relatively large subwatershed areas; situations involving diverse soil, slope, cover, and other factors for a contributing area; and in countries where research or previous USLE applications are lacking or nonexistent. In the user manual for the RUSLE2, the USDA ARS (2002) cautions that deriving spatially averaged slope, erodibility, or cover factors for drainage areas is an inappropriate use of the USLE. Because of nonlinearities in the underlying equations, such attempts to represent more diverse landscapes would produce inaccurate results (USDA ARS 2002). Auerswald et al. (2014) investigated the USLE K factor equation and found that it produced inaccuracies in more than half of the cases for a large soil dataset from Central Europe.

When used to estimate reduced sediment-bound pollutant loading, this method may understate the total WQB of that activity for pollutants that are common in both dissolved and particulate phases, such as nitrogen and phosphorus. The practitioner should understand the local water quality situation and whether the dominant form of pollutant (or pollutants) of concern is dissolved, particulate, or mixed, and then decide whether the USLE is the most appropriate method for quantifying WQBs for these pollutants that can be either primarily particulate or primarily dissolved in different situations.

An example application of the USLE method is provided in Table D3.1.

Table D3.1 | **Illustrative example of how to apply the USLE method**

CASE STUDY	AGROFORESTRY FOR COFFEE FARMERS
Activity	Agroforestry (including nursery establishment), landscape restoration, and conservation practices
Shared water challenges addressed	Water quality issues such as sediment and phosphorus loading linked to agricultural production areas in the watershed
Project description	This project involved the collective efforts of 65 coffee-growing families to implement agroforestry practices (including nursery establishment), landscape restoration (including plantings), and implementation of agriculture conservation practices intended to improve water quality and reduce runoff. These restoration activities took place on 25 hectares of land. An additional 25 hectares of landscape underwent forest preservation (forest enclosures).
Location	Magdalena Watershed, Colombia
Project start date	July 2022
Project end date	July 2023
Without-project condition	The project area to be restored by introduction of agroforestry practices had been impacted by deforestation and had a land cover consisting of a mixture of trees, brushland, grasses, and weeds.
With-project condition	After implementation of project activities, the project area would consist of agroforestry (including nursery establishment), landscape restoration, and conservation practices. The preserved project area consisted of undisturbed woods or forest with adequate tree canopy.

Table D3.1 | **Illustrative example of how to apply the USLE method (cont.)**

CASE STUDY	AGROFORESTRY FOR COFFEE FARMERS
WQB indicators	Reduced sediment load and reduced phosphorus load (for land restoration activities) and avoided sediment load and avoided phosphorus load (for land preservation activities)
WQB indicator calculations	Reduced sediment load (for restoration activities) and avoided sediment load (for preservation activities) were calculated using the USLE as implemented in a spreadsheet calculator. The phosphorus loading calculations relied on the sediment load estimates and soil phosphorus concentrations. Inputs to the USLE calculator were determined from site-specific characteristics (rainfall, slope, soil erodibility) and assumptions made for without- and with-project ground cover and supporting practice factors. The ground cover (C) factor for the undesirable conditions was assumed as 0.003 and for the desirable conditions (restored, preserved) as 0.001. The conservation practice (P) factor for the undesirable conditions was assumed as 1.0 and for the desirable conditions as 0.45. WQB = reduced sediment load = without-project sediment load – with-project sediment load = 48.4 MT/year – 3.4 MT/year = **45.0 MT/year** WQB = avoided sediment load = degraded landscape sediment load – preserved landscape sediment load = 48.4 MT/year – 2.5 MT/year = **45.9 MT/year** Applying a soil phosphorus concentration of 0.0011 kg-P/kg-sediment, WQB = reduced phosphorus load = **0.05 MT-P/year**, and WQB = avoided phosphorus load = **0.05 MT-P/year** The corporation's share of 100% of the total project cost would be applied to this total WQB.
Complementary indicator	Volumetric benefits: The volumetric water benefit is based on reduced runoff (for land restoration) or avoided runoff (for land preservation) from the project area, calculated using the Curve Number method. The volumetric water benefit calculated was 5.6 million liters per year for 2024–32. Other benefits not quantified include improved or maintained carbon sequestration, improved aquatic habitat availability and quality, and improved or maintained agricultural output.
Comments	To ensure reasonableness of results, an equivalent depth of soil loss was calculated based on an assumed bulk density for the site-specific soils and the without-project sediment loading rate. The resulting depth of soil loss, 0.039 cm/year, was a reasonable value. Additionally, a literature-based reference specific to the Magdalena River basin was used to confirm that the unit area loading rate for sediment derived using the USLE method was in the range reported by this independent study.
Considerations	Landscape restoration and preservation projects can provide long-term volumetric benefits. The company will claim benefits for up to 10 years after project completion. For each of these 10 years, the company's annual volumetric benefit will be a proportion of the total runoff benefit based on percentage of total project funding, provided there is annual evidence that the activities are functioning as intended. Because the first year of project implementation was a partial year, a time-based scaling factor was used to reduce the volumetric and water quality benefits computed for year one.

Notes: cm = centimeters; ha = hectares; kg = kilograms; MT = metric tons; UAL = unit area load; USLE = Universal Soil Loss Equation; WQB = water quality benefit.
Source: Authors.

D-4. Treatment System method

Methodology description

This method applies to structural practices intentionally installed to remove pollutants from nonpoint surface runoff, both in agricultural and developed landscapes. It can also apply to systems installed to address point source discharges, such as municipal wastewater effluent. The Treatment System method is analogous to the Volume Treated method described in the Volumetric Water Benefit Accounting (VWBA) guidance document (Reig et al. 2019), but this application in Water Quality Benefit Accounting (WQBA) focuses on the pollutant load retention by the treatment system as opposed to the volume of water treated.

Activities, pollutants, and indicators

A variety of both nature-based and traditional engineering practices fall within the list of activities where the Treatment System method might be appropriately applied. Examples of structural practices that might treat nonpoint source surface runoff in both agricultural and developed landscapes include constructed wetland treatment systems, retention and detention ponds, filtration devices, vegetative buffers or filters, and bioretention cells or rain gardens (Figure D-4.1). Like the Volume Treated method in the VWBA, it is also applicable to wastewater treatment plants, provided the new or improved treatment system being funded is addressing a locally relevant pollutant (or pollutants), that influent water has elevated concentrations of the pollutant(s), and that installation of the treatment plant is not required as part of regulations related to a company's operation in the location.

The Treatment System method is broadly applicable to any water quality pollutant that is a locally relevant pollutant (i.e., impaired or degraded water-body conditions linked to elevated levels of this pollutant) and can be demonstrated to be effectively reduced after installation of the practice or technology (i.e., through project-specific monitoring or well-proven pollutant removal capabilities). Examples include suspended solids, nutrients (nitrogen and phosphorus), metals (iron, copper, lead, etc.), biochemical oxygen demand, and organic compounds.

Reduced pollutant load and percent concentration reduction are appropriate indicators for the Treatment System method.

Figure D4.1 | **A bioretention system designed to treat nonpoint source runoff from an urban landscape**

Source: Authors.

Required inputs

When reduced pollutant load is the selected indicator for this method, a mass balance approach is commonly used, which involves estimating or quantifying the flow volumes (Q) and pollutant concentrations (C) entering and exiting the treatment system. Pollutant loads entering and exiting the system are then computed as the flow multiplied by the concentration multiplied by any necessary conversion factors, and the difference between the inlet and outlet is the mass of pollutant retained. Flow volumes and pollutant concentrations may be either measured through a monitoring program or estimated using project-specific calculations or peer-reviewed literature values.

If percent concentration reduction is the selected indicator for this method, then the required inputs are the pollutant concentrations (C) entering and exiting the treatment system. Again, the concentrations can either be determined from site-specific measurements or estimated using supporting information or literature.

Application

Step 1: Determine the annual inflow (Q_i) and outflow volumes (Q_o). Within the context of supporting water quality benefit (WQB) quantification, these volumes are expected to be equal for filtering or detention practices or wastewater treatment systems, while outflow may be less than inflow for practices that retain a significant portion of the water volume through infiltration or evapotranspiration processes. If percent concentration reduction is selected as the indicator, then this step is not necessary; however, if a VWB is going to be quantified for the project, then inflow and outflow volumes are needed regardless of the WQB indicator selected.

Step 2: Compile information regarding the concentrations of pollutant(s) flowing into the practice (C_i) that are above local water quality standards (i.e., the baseline concentration). This may be addressed by direct measurements, research into representative monitoring elsewhere in the vicinity, or appropriate literature-based values.

Step 3: Determine the effluent pollutant concentration (C_o). This may be estimated by direct measurements, research into representative monitoring elsewhere in the vicinity, use of locally applicable design criteria or equations, or use of model-based estimates such as regression models from published literature on similar practices. For example, Kadlec and Knight (1996), Kadlec (2016), and Mitsch and Jorgensen (2004) detail different approaches for determining effluent concentrations from treatment wetlands.

Step 4: Compute the WQB as either a reduced pollutant load or a percent concentration reduction.

WQB = reduced load = $(Q_i*C_i) - (Q_o*C_o)$

WQB = percent reduction = $(C_i - C_o) / C_i$

Hypothetical example

An onsite wastewater treatment facility installed at a remote state park campground was found to be deficient in reducing effluent fecal bacteria concentrations to acceptable standards. The effluent, which discharges to a creek running through the state park, was found through direct measurements to have an average fecal coliform concentration of 2,500 colony forming units (cfu) per 100 milliliters (mL), which was well above the 100 cfu/100 mL threshold. Human health concerns related to potential recreation in the creek are the shared water challenge of interest. To mitigate the water quality issue, a project was implemented that involved retrofitting the remote wastewater treatment facility with an ultraviolet disinfection system to destroy the pathogenic organism in the effluent water prior to discharge into the creek. Due to certain characteristics of the wastewater effluent, the ultraviolet system is not expected to fully sterilize the water, but as part of the engineering design work a conservative effluent concentration of 50 cfu/100 mL was assumed. The WQB for this project was computed as the percent reduction in fecal coliform concentration:

WQB = $(C_i - C_o)/C_i$ = (2,500 cfu/100mL – 50 cfu/100 mL)/2,500 cfu/100mL = 98% reduction

Caveats, assumptions, and other considerations

Sampling-based approaches for determining inlet and outlet concentrations should be conducted during conditions representative of times when most of the flow and loading is entering and exiting the treatment system, otherwise the WQB results may be misleading. For example, if an urban stormwater best management practice (BMP) experiences runoff inflow from 100 events per year, sampling during events of various magnitudes, small and large, should be conducted, as opposed to only sampling relatively smaller events.

With more monitoring and data collection comes greater certainty but also greater expense. The level of rigor and resources invested in the data collection should be tailored to the desirable outcomes and level of certainty needed for the project being considered. Regulatory or water quality–driven activities may require relatively more resources than a project where WQBs are a co-benefit but not the primary objective of the activity.

D-5. Water Quality Monitoring method

Methodology description

Numerous practitioners and organizations have developed a variety of field-based monitoring methods to quantify the water quality benefits of various practices. These direct-measurement approaches vary in complexity from occasional collection of grab samples to intensive mass balance studies that use specialized equipment to collect continuous or semicontinuous measurements of hydrologic and water quality parameters. The most significant advantage of these methods is the direct observation of the reduced pollutant loading or improvement in a water body's condition, which can result in high certainty in the water quality benefit. Unlike other methods, monitoring typically is not used to estimate the potential future WQBs from a project that has not yet begun, unless monitoring has been conducted on an existing system that closely resembles the future project and WQBs may be inferred for forecasting purposes.

Activities, pollutants, and indicators

Water quality monitoring is most appropriate for projects with a clearly defined inlet and outlet, relatively large-scale projects (e.g., thousands of hectares) where an in-stream improvement can be readily measured due to the proportion of the drainage area impacted, or projects needing to demonstrate that effluent meets a goal or target such as a water quality standard. Activities best suited for water quality monitoring include those with a well-defined inlet and outlet where measurements can demonstrate the improvement in water flowing through the system. Examples of practices include urban stormwater best management practices (BMPs) such as bioretention cells or retention ponds, edge-of-field agricultural structures such as bioreactors or water and sediment control basins, and constructed treatment wetlands, which can be used in a variety of settings (Figure D5.1).

Monitoring-based approaches are broadly applicable to any water quality pollutant that can be measured in situ or through laboratory analysis. Typical in situ measurements include water temperature, pH, turbidity (an indicator for suspended solids or sediment), conductivity (an indicator for salinity or dissolved solids), and dissolved oxygen. Water samples can also be collected manually or through automatic sampling devices for later analysis at a laboratory for numerous physical (e.g., total suspended solids), chemical (e.g., nitrogen, phosphorus, metals), or biological (e.g., chlorophyll) parameters.

The water quality indicators supported by water quality monitoring include reduced pollutant load (i.e., water volume or flow rate paired with concentration

Figure D5.1 | **Examples of monitoring equipment deployed for direct measurements of the water quality impacts of a constructed treatment wetland (left), a rain garden in an urban setting (center), and improved agricultural management practices (right)**

Source: Authors.

measurements), pollutant concentration (e.g., to demonstrate effluent compliance with a water quality standard), and percent reduction in concentration or temperature.

Applications

As described above, a number of field-based monitoring approaches may be used to quantify water benefits of stewardship practices with varying levels of complexity and temporal and spatial scales. Regardless of the method used, the five basic steps of a direct measurement approach (adopted from Brill et al. 2021) are identify the parameter(s) of concern; develop the monitoring program tailored to the situation, including level of rigor needed and resources available; implement the program; review and synthesize data; and calculate the water quality benefit using the appropriate indicator(s).

Alternative approaches of direct measurement methods for determining the water quality benefits of water stewardship activities include

- inlet/outlet: project-scale monitoring at the well-defined inlet and outlet of a constructed treatment practice (e.g., wetland, stormwater filtration device);
- before/after: monitoring both before and after a practice is implemented to determine the improvement at either a project scale (e.g., runoff from a single agricultural field) or a water-body scale (e.g., change in stream pollutant concentrations or water temperature); and
- experimental/control: project-scale monitoring of runoff from the site impacted by the water stewardship activity and an adjacent or nearby unaffected site (i.e., the control site).

Required inputs

For inlet/outlet monitoring programs, the required inputs are flow volumes and pollutant concentrations at the inlet and outlet of the activity if reduced pollutant load is the selected indicator. If a percent concentration reduction is the indicator, then monitoring of flow volumes is not needed.

- **WQB = reduced load =** $(Q_{in} * C_{in}) - (Q_{out} * C_{out})$
- **WQB = percent reduction =** $(C_{in} - C_{out}) / C_{in}$

For before/after monitoring programs, the required inputs are flow volumes and pollutant concentrations prior to project implementation and after project implementation if reduced pollutant load is the selected indicator. If a percent concentration reduction is the indicator, then monitoring of flow volumes is not needed. Before/after monitoring may be well suited for demonstrating the impact of projects focused on improving receiving water-body temperature regimes, and WQBs may be expressed as either the percent reduction in average water temperature (e.g., daily or weekly) or peak water temperature, depending on the local context.

- **WQB = reduced load = $(Q_{pre} * C_{pre}) - (Q_{post} * C_{post})$**
- **WQB = percent reduction = $(C_{pre} - C_{post}) / C_{pre}$**
- **WQB = average temperature percent reduction = $(Tavg_{pre} - Tavg_{post}) / Tavg_{pre}$**
- **WQB = peak temperature percent reduction = $(Tmax_{pre} - Tmax_{post}) / Tmax_{pre}$**

For experimental/control monitoring programs, the required inputs are flow volumes and pollutant concentrations at the experimental site (i.e., project implementation site) and the control site (unimpacted, reference location) if reduced pollutant load is the selected indicator. If a percent concentration reduction is the indicator, then monitoring of flow volumes is not needed.

- **WQB = reduced load = $[(Q_{control}/Area_{control}) * C_{control} - (Q_{project}/Area_{project}) * C_{control}] * Area_{project}$**
- **WQB = percent reduction = $(C_{control} - C_{experimental}) / C_{control}$**

Hypothetical example

A heavily modified urban stream experiences daily maximum water temperatures that exceed thresholds deemed appropriate for the native fish community. The extreme temperature regime is caused, in part, because the riparian corridor surrounding the creek lacks vegetative cover that would otherwise block solar radiation. A two-year monitoring study that involved continuous deployment of water temperature probes found that peak summertime water temperatures averaged 25°C during the worst one-week stretch, which was above the seven-day target threshold of 22°C. A project was implemented that included planting a mix of mature trees and shrubby vegetation on the banks of the stream over a half-mile stretch of the most exposed water surface. Post-implementation water temperature monitoring, completed using the same methods over a two-year period, found that peak summertime water temperatures were reduced to 21°C during the worst one-week stretch, just below the target threshold. The WQB for this project was computed as the percent reduction in peak water temperature:

WQB = $(Tmax_{pre} - Tmax_{post})/Tmax_{pre}$ = (25°C – 21°C)/25°C = 16% reduction

Caveats, assumptions, and other considerations

Although direct measurements can provide a highly certain estimate of water quality benefits, gathering sufficient data to develop an accurate understanding of the environmental system of interest can be both time- and labor-intensive. In addition to labor expenses, monitoring costs may include maintenance of automated equipment for sampling, field supplies, in situ measurement instruments (e.g., water level sensors and water quality sondes), and laboratory analytical costs. Also, depending on the spatial scale impacted by the project (or projects) relative to the area being monitored, attribution of measured benefits back to the specific activities may be challenging, as other changes on the landscape may impact the observed water quality at the monitoring point. While most methods in this document pertain to quantifying WQBs at a project scale, water-body scale monitoring may be appropriate in certain situations. Examples include stewardship projects that are expected to impact most of a water body's drainage area, such as grassland or cropland improvement programs implemented on thousands of acres in a common stream basin, collective action efforts where pooled funding from multiple entities is used to drive measurable change in a catchment, or when the activity targets a pollutant source known to be the sole or primary contributor to an impairment, such as acid mine drainage mitigation projects. Practitioners interested in using direct measurements to quantify water quality benefits should be prepared to develop a monitoring program that balances the resources required to conduct the monitoring with the level of rigor and certainty needed for the activity or local situation. For example, it may be acceptable to monitor a subset of representative projects as demonstration sites and then scale up the benefits to other projects scattered across the region. Developing and implementing a monitoring approach is often complex, and there is an inherent risk that even a reasonably designed approach may not yield the desired outcomes. Therefore, we strongly recommend that a practitioner with specific experience in designing and implementing monitoring protocols be involved throughout the process.

Practitioners can use a surrogate indicator to inform environmental conditions when direct measurement of primary parameters may be costly, difficult, or impractical. Many surrogate indicators are used in environmental sampling, such as dissolved oxygen for trophic conditions in water bodies, conductivity for total dissolved solids, and turbidity for total suspended solids. Although the use of surrogate indicators results in some uncertainty because the environmental outcomes are not directly measured, they may offer several advantages, including lower costs, repeatability and consistency across multiple sites, and general practicality and implementability as part of a benefit accounting program.

Example resources for practitioners to consult when developing a monitoring program include Dressing et al. (2016), Filoso et al. (2021), Geosyntec Consultants and Wright Water Engineers Inc. (2009), Stuntebeck et al. (2008), and Williams et al. (2016).

D-6. Modeling method

Methodology description

Several modeling methods and frameworks developed over the past several decades can be used to represent the movement of water over and through the landscape and the associated transport of sediment, nutrients, and other pollutants. Here we discuss three categories of mathematical models: mechanistic watershed-scale models, mechanistic field-scale models, and simple modeling approaches (e.g., empirical or regression models). Practitioners can use these models to quantify the benefits of corporate water stewardship projects implemented in agricultural, urban, and other settings.

Activities, pollutants, and indicators

Modeling methods are extremely versatile in their ability to estimate water quality benefits (WQBs) from different activities, for diverse landscapes, and many types of pollutants. Depending on the model selected, modeling can also be used to quantify all WQB indicators described in this document: reduced pollutant loading, avoided pollutant loading, percent concentration reduction, and pollutant concentrations in receiving water bodies. The trade-off for this versatility is that a greater investment of resources is required to develop and apply models, and this typically also includes acquiring existing data or new monitoring activities to support the modeling effort.

Required inputs

Two general types of input data are used in model applications: those needed to drive the model calculations and those used to evaluate and calibrate model performance. Although each model will require a unique set and format of inputs, common inputs for mechanistic models include the following:

- Meteorology (weather)
- Soil classification and attributes
- Land surface (slope, topography)
- Land use/land cover (vegetation, zoning, development)
- Operations/management (cropping system, fertilization, tillage)
- Specific-pollutant source information (point source discharges, septic system densities, livestock or wildlife types and densities)
- Drainage basin delineation and stream network characterization (length, width, slope)

The situations where modeling is most pragmatically selected as the WQBA method would include those where an existing model has been developed, calibrated, and documented by credible sources and therefore can be confidently applied with no new calibration. If a calibrated model is not available and the practitioner decides that modeling is the most appropriate method, comparisons of the model predictions against observed data are likely required. The process of model calibration involves comparing model predictions for state variables against site-specific measurements and iteratively adjusting model parameters within scientifically defensible limits to achieve an acceptable fit between predicted and observed values. Site-specific measurements used as these observed inputs during a calibration process may include water balance estimates (e.g., evapotranspiration vs. runoff), stream flow rates or velocities, lake water levels, water temperatures, pollutant concentrations, and pollutant load estimates.

Applications

Mechanistic watershed-scale models typically use algorithms to quantify the specific mechanisms controlling water flow and pollutant loading along hydrologic pathways in a large drainage basin context. They can be used to predict runoff from large areas and typically can simulate both in-stream and landscape processes. Pollutants represented depend on the model capabilities or the configuration for a particular watershed, but, in general, these tools can address the most common water quality constituents. Examples of commonly used watershed-scale models include the Hydrologic Simulation Program FORTRAN (HSPF), the Soil and Water Assessment Tool (SWAT), the Storm Water Management Model (SWMM), and the Source Loading and Management Model (SLAMM) (US EPA 2018).

Mechanistic field-scale models are similar to watershed-scale models but use a finer spatial resolution to represent individual parcels, farms, or urban neighborhoods. One can employ these models to simulate specific management practices and can help the manager see the effects on, for example, soil and nutrient dynamics. Pollutants represented depend on the model employed, but, in general, these tools can simulate the transport of sediment, nutrients, and pesticides. Like mechanistic watershed models, many of these models are traditionally not easy to use and are time- and resource-intensive to set up. Examples of commonly used field-scale models include the Agricultural Policy/Environmental eXtender Model (APEX) (Texas A&M AgriLife 2002); Chemicals, Runoff, and Erosion from Agricultural Management Systems (CREAMS); the Environmental Policy Integrated Climate (EPIC) model; Groundwater Loading Effects of Agricultural Management Systems (GLEAMS); and a web-based variation of APEX called the Nutrient Tracking Tool (NTT) (US EPA 2018).

A third modeling category includes a variety of relatively simpler modeling tools and approaches, including regression, empirical, mass balance, and spreadsheet models for predicting the water quality benefits of stewardship activities. Unlike the mechanistic, process-based watershed and field-scale models, these types of models or methods typically require fewer inputs and are less labor and skill intensive to use. Certain hybrid empirical and process-based models (such as the Spatially Referenced Regressions on Watershed Attributes [SPARROW] nonlinear regression model), however, can be tailored for specific applications and therefore involve a greater level of effort. Many of the tools in this category do not require calibration because they rely on previously observed relationships from other watersheds. Although the relative simplicity and "precalibrated" nature of these models makes them easier to use, this can also be a disadvantage due to greater uncertainty in model predictions or the potential for improper application of the model. If the underlying empirical relationships or assumptions were developed using observations from a specific location or land condition, it may be inappropriate to extend the model to represent other locations or conditions. In addition to SPARROW, other examples of simpler modeling tools include N-Visible (EDF 2020); the Region 5 Model; the Pollutant Load Estimation Tool (PLET) (Tetra Tech 2022), formerly the Spreadsheet Tool for Estimating Pollutant Load [STEPL]); and the Long-Term Hydrologic Impact Analysis (L-THIA) model (US EPA 2018).

The WQB may be calculated and expressed several ways when using the Modeling method. For all cases but the avoided pollutant load indicator, the models will be applied to simulate without-project (or baseline) conditions and a separate simulation for without-project conditions. WQBs may be expressed as the reduced pollutant load or precent concentration reduction, or, if water temperature is the parameter of interest, percent reduction in average water temperature or peak water temperature are calculated. When avoided pollutant load is the selected indicator, the baseline or current conditions represent the desirable WQ loading state, and a separate model simulation is used to estimate loading for a future degraded condition expected if the land conservation or preservation activity were not to take place.

- **WQB = reduced load = $(Q_{pre} * C_{pre}) - (Q_{post} * C_{post})$**
- **WQB = avoided load = $(Q_{degraded} * C_{degraded}) - (Q_{current} * C_{current})$**
- **WQB = percent concentration reduction = $(C_{pre} - C_{post}) / C_{pre}$**
- **WQB = average temperature percent reduction = $(Tavg_{pre} - Tavg_{post}) / Tavg_{pre}$**
- **WQB = peak temperature percent reduction = $(Tmax_{pre} - Tmax_{post}) / Tmax_{pre}$**

Hypothetical example

An extensive grassland in the Missouri River basin (United States) provides critical ecosystem services, including wildlife habitat, groundwater recharge, and beneficial water quality. The grassland has experienced historical conversion to cultivated cropland for food and fuel production, however, and threats of additional future conversion exist. To understand the importance of grassland preservation efforts aimed at avoiding increased sediment and nutrient loading to receiving water bodies, a large-scale, process-based modeling evaluation was conducted using SWAT (Flynn et al. 2017). The modeling study included coverage of the entire Missouri River basin. It involved developing state-specific model inputs to represent typical cultivated cropland management practices, and generating detailed tables of model output to facilitate WQB quantification as a function of state, climate region, soil category, and slope characteristics. Various reasonableness checks were performed to ensure that model behavior was appropriate and consistent with estimates produced by similar studies in the region. In an example project that involves funding the conservation of 1,000 acres of grassland in an area where conversion to cropland is imminent, the WQBs can be computed as the avoided pollutant load increases for sediment, nitrogen, and phosphorus from average modeling-based UALs reported in Flynn et al. (2017):

$WQB_{sediment}$ = area * $UAL_{sediment}$ = 1,000 acres * 1.8 tons/acre/year = 1,800 tons sediment/year

$WQB_{nitrogen}$ = area * $UAL_{nitrogen}$ = 1,000 acres * 16.9 lbs/acre/year = 16,900 lbs nitrogen/year

$WQB_{phosphorus}$ = area * $UAL_{phosphorus}$ = 1,000 acres * 3.5 lbs/acre/year = 3,500 lbs phosphorus/year

Caveats, assumptions, and other considerations

Careful consideration should be given prior to selecting the Modeling method for computing WQBs, and, if modeling is chosen, the practitioner should undertake a model selection process to determine the most appropriate model for the local situation. Several resources are available to aid in this process, including guidance developed by the Montana Department of Environmental Quality (2016), US EPA (2018), BWSR (2019), and ESMC (2020).

Practitioners often use watershed-scale mechanistic models for regional water quality assessments and to inform watershed improvement plans for pollutant load reduction (e.g., total maximum daily loads). In many cases, a rigorous application of a model is conducted with comprehensive datasets, detailed calibration, and scenario analysis. This process is typically cost- and time-intensive. For the purposes of WQBA and the interests of the corporate water stewardship community, resource needs should be considered. If a field-scale or watershed-scale mechanistic model previously developed and applied is readily available (i.e., open source or otherwise obtainable by the practitioner), it may be the best option to support a WQBA calculation.

D-7. Region-specific methods

Methodology description

Taking into account that water quality pollution issues are typically identified, investigated, and mitigated at a local or regional level (e.g., a watershed or catchment scale), Region-specific methods involve the use of local- or region-specific models, tools, or other approaches to quantify the water quality benefits (WQBs) of water stewardship activities. Voluntary or prescribed pollutant reduction plans are typically developed for an entire region or watershed using methods intended to ensure fairness, equity, and effectiveness for all sources (industries, municipalities, agricultural producers, private landowners, etc.) that contribute to the pollution problem. Part of the planning and implementation process may involve development of a new tool or recommendation of an existing approach for estimating the pollutant load reductions or other water quality benefits of the various actions that responsible entities can carry out to mitigate the impairment. Because such methods are generally pollutant-specific, site-specific, practical to execute, and developed, accepted, or recommended by the responsible environmental agencies, when available they may present the best alternative for quantifying the WQBs of corporate water stewardship projects.

Activities, pollutants, and indicators

The activities, pollutants, and indicators available will be dictated by the Region-specific method selected. In general, estimating WQBs using this approach will allow for selection of a variety of different activities, for diverse landscapes and the pollutant (or pollutants) of greatest concern, but those selections will be limited within the existing site-specific quantification method (i.e., the activities, pollutants, and indicators are inherited from the method that is selected). Perhaps the most frequently encountered local- or region-specific approaches quantify reduced pollutant load as the indicator, for nutrients (nitrogen and/or phosphorus) as the pollutant, and for different urban and agricultural best management practices (BMPs) as the activities.

Required inputs

The documentation of Region-specific methods should be referenced to determine the required inputs, which will be unique to a given method. Practitioners seeking to use a Region-specific method should be prepared to compile basic project information that is common across several WQBA methods and likely required by the Region-specific method selected, including characteristics of the drainage area impacted by the activity (location, size, land use or land cover type, imperviousness, soils, slope, etc.) and specifications of the project or activity (type of action, size or dimensions, expected longevity, etc.).

Applications

Each Region-specific method is applied to specific situations depending on its individual purpose and requirements. Table D7.1 lists example tools or models developed and applied for understanding nutrient and bacteria load reductions in various locations.

Hypothetical example

Total maximum daily loads (TMDLs) have been established for phosphorus loading to Lake Champlain (United States) due to eutrophication and exceedance of water quality standards (US EPA 2016). A region-specific tool called the Vermont Clean Water Roadmap was developed to aid decision-makers in developing strategies to implement projects that would make progress toward meeting TMDL goals. The technical foundation of the tool included baseline watershed modeling and BMP reduction efficiency compilation work that authorities used during TMDL development. Because the Clean Water Roadmap was specifically designed to support planning related to implementation of phosphorus load-reduction projects, it represents an appropriate Region-specific method for evaluating the WQBs of a large variety of activities in Vermont's Lake Champlain drainage basin. An example project was implemented in a subwatershed of the Otter Creek basin involving the use of livestock exclusion fencing with riparian buffers on pastureland. The baseline (without-project) phosphorus loading attributable to pastureland for the subwatershed is 64 kg-P/yr. Assuming all pastures in the entire subwatershed receive the livestock exclusion with riparian buffers, which has a default phosphorus reduction efficiency of 73 percent according to the tool, the WQB for this project was computed as a reduced phosphorus load using the Vermont Clean Water Roadmap:

$WQB = L_{pre} * \%\ reduction = 64\ kg\text{-}P/year * 73\% = 47\ kg\text{-}P/year$

Table D7.1 | **Tools for evaluating nutrient and bacteria load reductions**

CATEGORY	NAME AND DESCRIPTION	REFERENCES
Nutrients	Chesapeake Assessment and Scenario Tool (CAST): a suite of modeling tools developed specifically for the Chesapeake Bay Watershed in the eastern United States to simulate the nitrogen, phosphorus, and sediment load reductions associated with a wide variety of best management practices.	CBP 2020
	Clean Water Roadmap: a web-based tool for evaluating phosphorus load-reduction strategies in the Lake Champlain basin of Vermont.	LimnoTech 2017
	Watershed Nitrogen and Phosphorus BMP Assessment Tools (NBMP, PBMP, and NP-BMP): spreadsheet planning tools for estimating nutrient reductions from agricultural sources in the state of Minnesota.	Lazarus et al. 2014, 2015
	Canadian Nutrient and Water Evaluation Tool (CANWET): a GIS-based nutrient and water budget tool initially applied to Canada's Lake Simcoe and Lake Erie watersheds, with a later application for sodium chloride in Waterloo, Ontario.	Greenland Technologies Group 2025
	Geospatial Regression Equation for European Nutrient losses (GREEN): a statistical model that estimates nitrogen and phosphorus loading to marine environments, including annual load contribution estimates from major source categories.	Grizzetti et al. 2021
	Urban Nutrient Decision Outcomes (UNDO): an online decision-support tool used in Western Australia for understanding nutrient reduction alternatives in urban settings.	Government of Western Australia 2016
Bacteria	Bacteria Source Load Calculator (BSLC): a tool developed by Virginia Tech and used in several bacterial TMDL studies in the state to understand bacteria load sources and mitigation strategies.	Zeckoski et al. 2005
	Bacteria Loading Estimator Spreadsheet Tool (BLEST): developed by CDM, the University of Houston, and the Texas Commission on Environmental Quality for application in a Texas watershed with bacteria impairments and later adapted to other areas, such as California.	Petersen et al. 2009
	Indiana E. Coli Calculator (IEC): a spreadsheet tool based on the US EPA Bacteria Indicator Tool (BIT) for application in the state of Indiana to understand bacteria source contributions from cropland, pasture, development, and forest landscapes, as well as reductions from BMP implementation.	IDEM 2020

Notes: BMP = best management practice; EPA = Environmental Protection Agency; TDML = total maximum daily load.

Source: Authors.

Caveats, assumptions, and other considerations

Each Region-specific method carries caveats, assumptions, and other considerations that must be taken into account when applying the method. Practitioners should be aware of any limitations of the tool or model being applied to perform a WQB quantification and acknowledge these when reporting results.

While Region-specific methods may offer the best WQB quantification approach for certain locations, project types, and pollutants, this approach can also be limiting in that extending a tool or model beyond the circumstances it was developed for might be an inappropriate use of the approach. For example, assuming that the pollutant load-reduction results reported by the region-specific tool are applicable to other geographies would be a potential misuse, unless the practitioner can confirm or justify such an extension through evidence that the alternative area of application is of very similar characteristics. Similarly, a Region-specific method should only be applied to prepopulated activity types and the pollutant(s) it was developed for.

Appendix E. Make a tracking and reporting plan

The following information is intended to guide efficient, effective, and credible project-level tracking and reporting to substantiate water quality benefit (WQB) claims and progress against goals. Four components are described below.

Determine primary tracking and reporting requirements to claim WQBs

A project that meets the eligibility criteria outlined in Step 2 offers assurances that it is eligible to generate expected WQB outputs that contribute to desired outcomes. For such projects, primary project tracking and reporting is required to make a WQB claim and can focus on *implementation activities* and WQB *outputs* when a clear theory of change demonstrates how the supported activities will address shared water challenges and contribute to long-term desired impacts (Figure E-1).

As illustrated in Figure E-1, primary tracking and reporting to confirm WQBs requires confirming the following:

Successful completion of implementation activities. Implementation activities are essential project implementation tasks that must be completed before the project can deliver its intended WQB outputs. Tracking and reporting of these activities confirms that the essential project activities have been successfully completed and that the project is positioned to deliver expected WQB outputs.

AND EITHER

Measured WQB outputs. In cases where direct measurement of annual WQB outputs is feasible or practical, initial confirmation of completed implementation activities and subsequent annual tracking and reporting of pollutant load reduction is sufficient.

OR

Modeled WQB outputs and key performance factors necessary to sustain project function over the claim period. In cases where direct measurement of annual WQB outputs is not feasible or practical (e.g., measuring reductions in nonpoint source runoff), WQBs will be modeled using relevant climate, environmental, project, and/or hydrologic data. Tracking and reporting should confirm completion of implementation activities and verify annual performance factors (Table E-1) on which WQB calculation methods are based and sustained project function and viability depend (Figure E-1). Performance factors are conditions or key project-related elements that must remain in place (year over year) to sustain a project's ability to deliver WQB outputs over the claim period. The type or relative importance of performance factors is project- and context-specific.

Determine if secondary tracking and reporting of other outputs as well as broader outcome and impact metrics is necessary

Secondary tracking and reporting of other outputs, outcomes, and long-term impacts may also be desired but is not required to make a WQB claim. If such tracking is desired, it is important to communicate these needs with implementing partners prior to contracting so that progress compared to "without-project" conditions can be evaluated. Additional discussion on this topic is covered under Step 5.

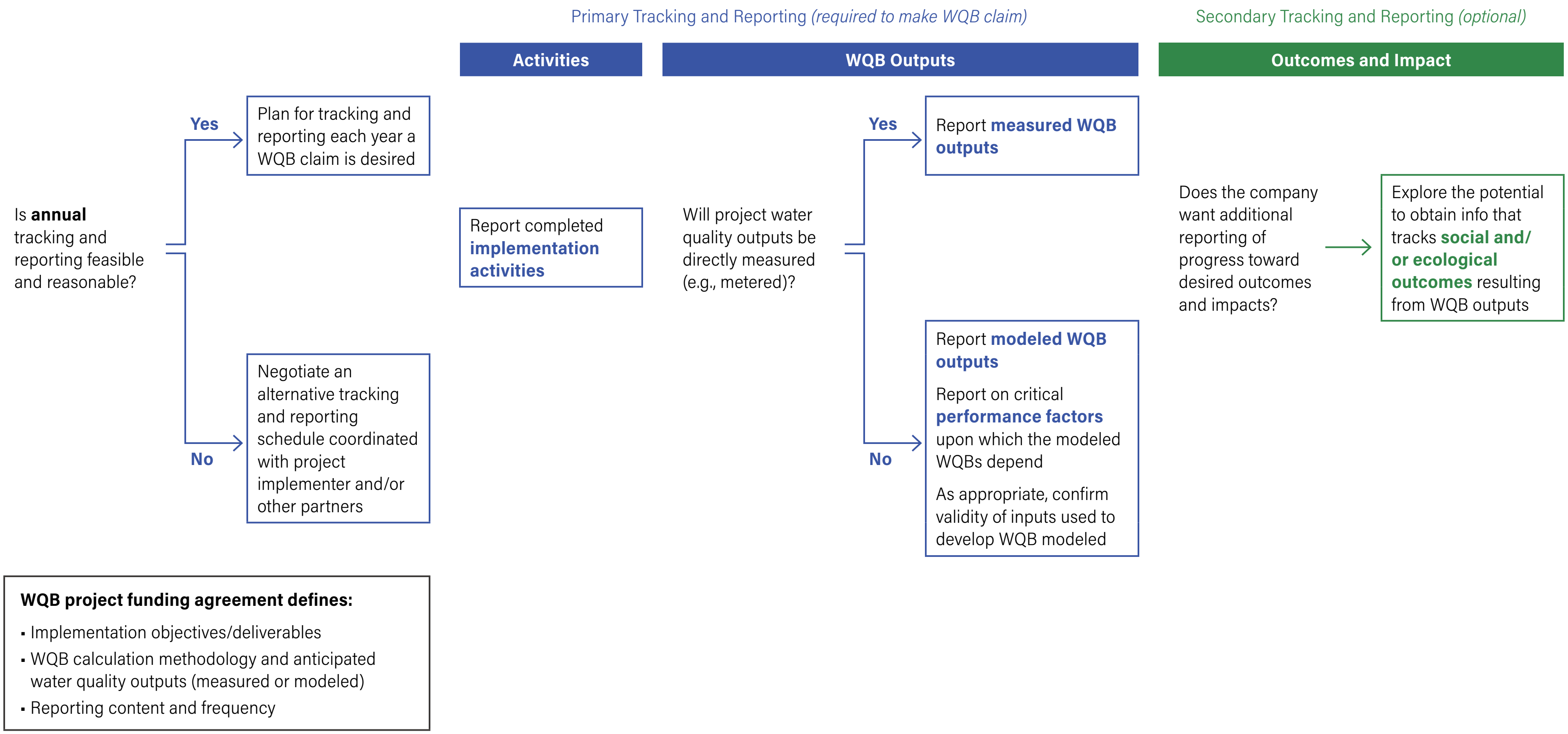
Determine the necessary duration and frequency of project tracking and reporting to align with desired annual WQB claims

Following project implementation and for each year in which a WQB claim is made, the best practice is that companies obtain key tracking and reporting information to help meet the communication requirements provided in Step 6.

Although annual tracking and reporting are often the best way to validate ongoing project performance, under some circumstances it may not be useful, practical, or feasible to obtain certain key information each year. For example, internal policy, funding availability, capacity limitations of project implementers, access to project sites, project type, weather, and other factors may limit or preclude collection of annual tracking and reporting information.

Evaluating the circumstances case by case, companies should work closely with project implementers to define the nature, frequency, and duration of tracking and reporting to meet the needs of the company and reflect the project circumstances and capacity of parties responsible for tracking and reporting.

Figure E-1 | **WQBA primary and secondary tracking and reporting**



Notes: WQB = water quality benefit; WQBA = Water Quality Benefit Accounting.
Source: Authors.

Table E-1 | **Performance factor types and example performance factors that may be tracked to determine whether a project is delivering water quality benefits**

PERFORMANCE FACTOR TYPE			
Legal/governance/agreement	**Hydrologic/biophysical**	**Structural**	**Operational/behavioral**
Is the project's ongoing water quality performance contingent on certain legal, policy, authorization, permitting, or enforcement elements that may or may not be approved, renewed, or assured each year?	Is there significant hydrologic or environmental variation that directly affects annual water quality performance? And/or are historical hydrologic data increasingly less predictive of current conditions due to climate change or other factors?	Does the project require certain structural (natural or nonnatural) components that may be subject to failure or underperformance and/or require annual maintenance to sustain performance?	Does the project rely extensively on ongoing management, behavior, maintenance, and/or human inputs to sustain function?
Example performance factors that can influence WQB outputs			
▪ Time-restricted permits ▪ Conservation easement compliance ▪ Land management agreements	▪ Biophysical processes critical to fulfill project function, such as survival of planted trees or wetland vegetation ▪ Hydrologic conditions needed to fulfill project function, such as adequate precipitation or runoff	▪ Control structures that retain nutrients ▪ Rainwater or stormwater delivery and catchment systems ▪ Sanitation facilities to safely discharge or reuse wastewater	▪ Agriculture producer's application of management practices ▪ City management of detention ponds

Note: WQB = water quality benefit.
Source: Authors.

For example, tracking information for a project that will be in operation for 10 years may be collected and reported annually for a predetermined period (e.g., three to five years) up to a point at which a project is expected to reach a state of stable function (e.g., new or enhanced gray or green infrastructure that is built and operated in a manner that demonstrates stable performance and meets original design criteria). At that point, the company and project implementer can reevaluate the nature and terms of tracking and reporting to determine if a less frequent or reduced level of tracking and reporting can provide sufficient assurance of continued project performance for the balance of a 10-year claim period.

Work with project implementers to make a tracking and reporting plan

Companies should work with project implementers to define the timing and scope of tracking and reporting requirements needed to meet the company's information needs, account for the cost and feasibility of collecting and documenting key information, and realistically evaluate the project implementer's capacity to carry out tracking and reporting actions over the desired term.

Many project implementers operate with limited resources and lack capacity and funding to carry out tracking and reporting activities beyond those that directly inform their own progress toward strategic goals. If desired tracking and reporting requirements represent an added financial and/or capacity burden, companies should integrate those costs into the project budget to ensure that tracking and reporting activities are supported over the duration of the WQB claim period. If desired reporting and tracking requirements are realistically beyond the capacity of project implementers (or not aligned with their priorities), companies should identify and use other agents, tools, or pathways to perform key tracking and reporting functions over the duration of the WQB claim period.

Adopting a tracking and reporting approach that provides value to both the company and project implementers is a useful objective, and it is desirable to base company tracking and reporting needs on reporting systems that may already be funded and in place.

Appendix F: Guidance for ensuring reasonableness of results

The Water Quality Benefit Accounting (WQBA) methods recommended in this guidance are intended to support the estimation of water quality benefits (WQBs) without requiring extensive technical resources. Regardless of which pollutants are evaluated or the methods employed, the results obtained from the WQBA methods should be carefully checked and critically evaluated to ensure that they provide a defensible estimate of the benefit. In some cases, secondary evaluation of the results may require more effort than the primary calculation, but these checks are vital to avoid overstatement of benefits, which may carry the risk of critique by external experts or other third parties. The evaluation of WQBA method results should involve one or more of the following components:

- Comparison with other available results for activities or methods under similar landscape conditions (e.g., literature sources, the company's portfolio of projects and quantified benefits).
- Best professional judgment, as provided by an internal or external water quality expert.
- Checks of model inputs and coefficients, assumptions, or individual processes to ensure reasonableness based on other published studies, experience, or qualitative knowledge gained in applying the method. (ASABE 2017)

Reasonableness checks

Which specific comparisons and checks are most appropriate for a particular WQBA application will depend on the pollutant (or pollutants) of interest, without-project conditions in the affected area, the nature of the activity, and the details and potential uncertainties of the method employed. However, some general guidelines for conducting "bounding" and "comparability" checks are outlined in Table F-1.

Additional considerations

Consideration should be given to alternative WQBA methods or other available estimates (e.g., literature-based) if it is determined that the applied method either generates an unrealistic without-project UAL or pollutant concentration, or appears to overstate the relative pollutant load or pollutant concentration reduction.

The types of reasonableness checks outlined above should be conducted in the context of ensuring that the reported benefit is defensible and errs on the side of being conservative, which is particularly important for estimates that carry a higher degree of uncertainty. In cases where there is significant concern or perceived uncertainty with a WQBA estimate, it is advisable to engage with an experienced water quality practitioner to provide additional review and direction prior to finalizing and publishing the benefit estimate.

Table F-1 | **General guidance for reasonableness checks**

RESULT TYPE	BOUNDING CHECKS	COMPARABILITY CHECKS
Absolute pollutant loads or pollutant concentrations	For sediment load and/or load reduction over a specific area (e.g., for reforestation), is the associated change in sediment "depth" on the landscape reasonable based on values derived from the literature? Does the calculation represent unrealistic erosion or other delivery from the land surface (e.g., more than a few centimeters of sediment erosion)?	Do the unit area loads (UALs, e.g., kg/ha/yr) estimated using the method compare favorably with UALs reported in the literature or elsewhere for similar landscapes?
Relative change in pollutant loads or pollutant concentrations	Is the percent reduction of a pollutant unexpectedly high (e.g., >90%)? If so, is this justifiable given the type of activity and the without-project condition of the landscape or water body?	Are estimates of relative (%) load reduction for the pollutant available from other quantification work or studies that can be compared against?

Note: UALs are most commonly available for nutrients, sediments, and bacteria.
Source: Authors.

Glossary

Activity: The interventions whose effects on natural and social capital are considered "outputs" and can be analyzed and quantified (adapted from WBCSD 2017). A water stewardship project may encompass multiple activities.

Attribution: The distribution of water quality benefits among organizations where multiple organizations share a common water quality benefit.

Basin: See "**Catchment**."

Benefit: Long-term social, economic, and environmental effects resulting from the implementation of a project or activity, either directly or indirectly, intentionally or unintentionally. Benefits, which are the ultimate result, derive from outcomes and can also be referred to as positive impacts (those impacts which directly or indirectly, intentionally or unintentionally, generally benefit relevant parties and/or the environment) (adapted from AWS 2020).

Biological water quality issues: The presence of harmful microorganisms such as bacteria, viruses, and parasites. Sewage, agricultural runoff, and animal waste can enter water bodies through a variety of sources. At the community level, these contaminants can cause water-borne illnesses and diseases, such as cholera, dysentery, and hepatitis. Contaminated drinking water or direct contact with contaminated water can be possible transmission pathways for these diseases.

Catchment: Also referred to as "watershed." The area of land from which all surface runoff and subsurface waters flow through a sequence of streams, rivers, aquifers, and lakes into the sea or another outlet at a single river mouth, estuary, or delta (adapted from AWS 2020). It is important to consider that catchments

- include associated groundwater areas, but surface and subsurface waters often have different catchment boundaries and degrees of connection;
- may include the totality or portions of water bodies, such as lakes or rivers;
- are also referred to as watersheds, basins, or subbasins; and
- may be interconnected with infrastructure, so interventions in one can result in benefits or detriments in another.

Chemical water quality issues: The presence of harmful chemicals in water that can be detrimental to human health and the environment. These chemicals can be derived from various sources, such as industrial waste and air pollution, agricultural runoff, stormwater runoff, or process wastewater (US EPA 2013). Some common chemical water quality issues include nutrients and heavy metals such as lead and arsenic, which can cause serious human health effects.

Claim: To state or declare the creation of water quality benefits.

Collective action: Coordinated engagement among interested parties within an agreed-upon process in support of common objectives. Water-related collective action refers to specific efforts to advance sustainable water management, whether through encouraging reduced water use, improved water governance, pollution reduction, river restoration, or other efforts.

Goal: A description of a desired objective, set at the enterprise or site level, against which the company and other entities can evaluate progress (adapted from CEO Water Mandate 2014). This term is used synonymously with other commonly used language to describe desired objectives, such as targets and commitments.

Gray infrastructure: Built structures and mechanical equipment, such as reservoirs, embankments, pipes, pumps, water treatment plants, and canals. These engineered solutions are embedded within watersheds or coastal ecosystems whose hydrological and environmental attributes profoundly affect the performance of the gray infrastructure (Browder et al. 2019).

Green infrastructure (also sometimes called natural infrastructure, or engineering with nature): Infrastructure that intentionally and strategically preserves, enhances, or restores elements of a natural system, such as forests, agricultural land, floodplains, riparian areas, coastal forests (such as mangroves), among others, and combines them with gray infrastructure to produce more resilient and lower-cost services (Browder et al. 2019).

Impact: Changes in the well-being of those affected over the longer term (WBCSD 2017). In the context of water stewardship, "impact" refers to the positive or negative long-term social, economic, and environmental effects resulting from the implementation of a project or activity, either directly or indirectly, intentionally or unintentionally. Impacts, that are the ultimate result, derive from outcomes. Impacts may be beneficial (those impacts which directly or indirectly, intentionally or unintentionally, generally benefit relevant parties and/or the environment) or adverse (those impacts that directly or indirectly, intentionally or unintentionally, are generally harmful to relevant parties and/or the environment) (adapted from AWS 2020).

Indicator: A quantitative factor or variable that provides reliable means to quantify the achievement of outputs.

Outcome: Changes in the lives of the target population and/or environment (WBCSD 2017). In the context of water stewardship, the Alliance for Water Stewardship Standard contains four outcomes: good water governance, sustainable water balance, good water quality status, and healthy status of important water-related areas. Outcomes derive from outputs and lead to impacts (adapted from AWS 2020).

Output: The results of the activity in question (WBCSD 2017). In the context of Water Quality Benefit Accountuing, water quality benefits are considered outputs that derive from water stewardship activities and lead to broader social, economic, and environmental outcomes and ultimately impacts.

Performance factor: The conditions or elements that must be in place to sustain a project's ability to deliver water quality benefits over the claim period.

Physical water quality issues: The presence of physical contaminants in water, such as debris, sediment, and other foreign objects. These can be caused by a variety of factors, including stormwater runoff, erosion, and industrial activities. Other types of linked physical water quality issues are increased temperatures and reduced dissolved oxygen, which can impact the health and survival of aquatic life.

Practitioner: A general term to refer to anyone in the corporate water stewardship space.

Project: A single water stewardship activity or multiple activities implemented in a specific site or range of sites.

Reasonableness: Refers to the processes of reviewing and checking quantification results to ensure that a realistic outcome that does not overstate benefits is produced.

Reporting: The formal development and sharing of information to communicate a project or program's progress toward predefined objectives (or targets). The content and frequency of reporting is usually defined in a formal agreement.

Root cause: The fundamental reason and underlying driver for the occurrence of a problem (e.g., the shared water challenge).

Shared water challenge: The water-related issues that are of interest or concern in the catchment or area of interest (e.g., aquifer, municipality, town, state) and which, if addressed, will provide positive impacts or prevent negative impacts. Shared water challenges are not necessarily unique and may be the same for multiple sites or entities that rely on a water resource (adapted from AWS 2020).

Spatial scale: The size or extent of the area being studied (i.e., consideration of physical dimensions in space, such as the size of a watershed, catchment, or river basin).

Sponsor: The organization (e.g., corporation) that funds some or all of the water stewardship project activity, with the intent of making water quality benefit claims based on their investment.

Strategic watershed objective: A common goal shared by the company and other relevant parties in the catchment that contributes to meeting a shared vision for the catchment.

Temporal scale: The time frame over which hydrological processes are observed and analyzed (i.e., considerations of time intervals, such as hours, days, months, or years).

Tracking: Evaluation of key metrics to assess progress toward defined targets.

Volumetric Water Benefit Accounting: The method for quantifying the volumetric water benefits of water stewardship activities, and associated guidance related to planning, project selection, tracking and reporting, and communication.

Volumetric water benefits: The volume of water resulting from water stewardship activities, relative to a unit of time, that modify the hydrology in a beneficial way and/or help reduce shared water challenges.

Water quality: Refers to the chemical, physical, and biological characteristics of water relative to the water's desired use (Cordy 2001).

Water quality benefits: The water pollutant reductions resulting from water stewardship activities that modify the receiving water body in a beneficial way and help mitigate shared water challenges, improve water stewardship outcomes, and meet the targets of Sustainable Development Goal 6 (UN n.d.).

Water quality objective: A description of how the activity will contribute to addressing a shared water challenge by improving the quality of the water.

Water risk: The effect of water-related uncertainty on an organization's objectives. It is important to note that water risk is experienced differently by every sector of society and the organizations within them and thus is defined and interpreted differently (even when the same degree of water scarcity or water stress is experienced or when it affects the same area of interest) (adapted from AWS 2014).

Watershed: See "**Catchment**."

Water stewardship: The socially equitable, environmentally sustainable, and economically beneficial use of freshwater, achieved through a stakeholder-inclusive process that involves site- and catchment-based actions (AWS 2020).

With-project conditions: The circumstances or points after a project is implemented that an organization or activity can use to evaluate progress or make comparisons (adapted from AWS 2020).

Without-project conditions: The beginning points at which an organization or activity will be monitored and against which progress can be assessed or comparisons made (adapted from AWS 2020).

WQB claim: To state or declare the creation of water quality benefits. This includes any statement, accounting, or communication regarding the delivery of existing or anticipated water quality benefits that result from voluntary actions taken by the entity making the claim.

Abbreviations

AWS Alliance for Water Stewardship

BMP best management practices

CAPEX capital expenditure

CN curve number

EC export coefficient

EMC event mean concentration

HSG hydrologic soil group

OPEX operational expenditure

RUSLE Revised Universal Soil Loss Equation

SWAT Soil and Water Assessment Tool

TMDL total maximum daily load

TNC The Nature Conservancy

UAL unit area load

US EPA US Environmental Protection Agency

USLE Universal Soil Loss Equation

VWB volumetric water benefit

VWBA Volumetric Water Benefit Accounting

WASH water access, sanitation, and hygiene

WQ water quality

WQB water quality benefit

WQBA Water Quality Benefit Accounting

WRI World Resources Institute

References

Akhtar, N., M.I.S. Ishak, S.A. Bhawani, and K. Umar. 2021. “Various Natural and Anthropogenic Factors Responsible for Water Quality Degradation: A Review.” *Water* 13 (19): 2660. https://doi.org/10.3390/w13192660.

Anning, D.W, and M.E. Flynn. 2014. “Dissolved-Solids Sources, Loads, Yields, and Concentrations in Streams of the Conterminous United States.” US Geological Survey Scientific Investigations Report 2014-5012. http://dx.doi.org/10.3133/sir20145012.

ASABE (American Society of Agricultural and Biological Engineers). 2017. *Guidelines for Calibrating, Validating, and Evaluating Hydrologic and Water Quality (H/WQ) Models*. ASABE EP621.

Auerswald, K., P. Fiener, W. Martin, and D. Elhaus. 2014. “Use and Misuse of the K Factor Equation in Soil Erosion Modeling: An Alternative Equation for Determining USLE Nomograph Soil Erodibility Values.” *CATENA* 118: 220–25.

AWS (Alliance for Water Stewardship). 2014. *The AWS International Water Stewardship Standard.* Alliance for Water Stewardship. https://a4ws.org/wp-content/uploads/2017/04/AWS-Standard-Full-v-1.0-English.pdf.

AWS. 2020. *AWS Standard 2.0 Guidance*.

Beaulac, M.N., and K.H. Reckhow. 1982. “An Examination of Land Use: Nutrient Export Relationships.” *Water Resources Bulletin*, paper no. 82077. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-1688.1982.tb00109.

Boyd, C.E. 2020. *Water Quality: An Introduction*. Springer International. https://doi.org/10.1007/978-3-030-23335-8.

Brill, G., T. Shiao, C. Kammeyer, S. Diringer, K. Vigerstol, N. Ofosu-Amaah, M. Matosich, et al. 2021. *Benefit Accounting of Nature-Based Solutions for Watersheds: Guide.* Oakland, CA: UN CEO Water Mandate and Pacific Institute.

Brill, G., D. Carlin, S. McNeeley, and D. Griswold. 2022. *Stakeholder Engagement Guide for Nature-Based Solutions*. UN CEO Water Mandate and Pacific Institute. www.ceowatermandate.org/nbs/engagementguide.

Browder, G., S. Ozment, I. Rehberger Bescos, T. Gartner, and G.-M. Lange. 2019. *Integrating Green and Gray: Creating Next Generation Infrastructure.* World Resources Institute. https://www.wri.org/research/integrating-green-and-gray-creating-next-generation-infrastructure.

BWSR (Minnesota Board of Water and Soil Resources). 2019. *Water Quality Model, Tool, and Calculator Basics: Reference Guide*. April.

CBP (Chesapeake Bay Program). 2018. *Chesapeake Bay Program Quick Reference Guide for Best Management Practices (BMPs): Nonpoint Source BMPs to Reduce Nitrogen, Phosphorus and Sediment Loads to the Chesapeake Bay and Its Local Waters*. CBP/TRS-323-18.

CBP. 2020. *Chesapeake Assessment and Scenario Tool (CAST) Version 2019*. Chesapeake Bay Program Office.

CEO Water Mandate. 2024. *Implementing Net Positive Water Impact: Technical Guidance*. https://ceowater-mandate.org/resources/net-positive-water-impact-technical-guidance/.

Christ, K.L., and R.L. Burritt. 2017. "Water Management Accounting: A Framework for Corporate Practice." *Journal of Cleaner Production* 152: 379–86. https://doi.org/10.1016/j.jclepro.2017.03.147.

Clary, J., J. Jones, M. Leisenring, P. Hobson, and E. Strecker. 2020. "International Stormwater BMP Database: 2020 Summary Statistics." Water Research Foundation (WRF) Project Number 4968.

Cordy, Gail E. 2001. "A Primer on Water Quality." Reston, VA: US Geological Survey. FS-027-01.

CWP (Center for Watershed Protection Inc.) and CSN (Chesapeake Stormwater Network). 2008. "Technical Memorandum: The Runoff Reduction Method." April 18.

Damania, R., S. Desbureaux, A.-S. Rodella, J. Russ, and E. Zaveri. 2019. *Quality Unknown: The Invisible Water Crisis*. Washington, DC: World Bank. https://doi.org/10.1596/978-1-4648-1459-4.

Dressing, S.A., D.W. Meals, J.B. Harcum, J. Spooner, J.B. Stribling, R.P. Richards, C.J. Millard, et al. 2016. *Monitoring and Evaluating Nonpoint Source Watershed Projects*. Developed under contract to US EPA by Tetra Tech Inc. EPA 841-R-16-010. May.

EDF (Environmental Defense Fund). 2020. *N-Visible: A Nitrogen Balance Framework*. September.

ESMC (Ecosystem Services Market Consortium). 2020. "Ecosystem Services Markets Conceived and Designed for Agriculture: An Assessment of Protocols, Methodologies, Tools and Approaches to Inform ESMC's Integrated, Tiered Ecosystem Services Market Protocol for Working Agricultural Lands." https://www.landcan.org/pdfs/ESMC-Report-January-2020.pdf.

Filoso, S., P. Petry, and L. Wainger. 2021. *Measuring and Evaluating the Impact of Corporate Watershed Projects: A Guide to Set Project Objectives, Track Progress and Assess and Communicate Impact*. Arlington, VA: The Nature Conservancy and AB InBev.

Flynn, A., A. Gage, C. Boles, B. Lord, D. A. Schlea, S. Olimb, T. Redder, and W. Larson. 2017. "Quantifying the Environmental Benefits of Conserving Grassland." *Journal of Management and Sustainability* 7 (2): 65–77.

Foster, G.R., D.K. McCool, K.G. Renard, and W.C. Moldenhauer. 1981. "Conversion of the Universal Soil Loss Equation to SI Metric Units." *Journal of Soil and Water Conservation* 36 (6): 355–59.

Frankel, T.C. 2014. "The Toxin That Shut Off Toledo's Water? The Feds Don't Make You Test for It." *Washington Post*, August 11. https://www.washingtonpost.com/news/storyline/wp/2014/08/11/watching-toledos-toxic-water-troubles-with-a-wary-eye-and-few-regulations/.

Garrison, N., J. Sahl, A. Dugger, and R. Wilkinson. 2014. "Issue Brief: Stormwater Capture Potential in Urban and Suburban California." Natural Resources Defense Council and Pacific Institute.

Gartner, T., J. Mulligan, R. Schmidt, and J. Gunn. 2013. *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States*. World Resources Institute, Earth Economics, and Manomet Center for Conservation Sciences. https://www.wri.org/research/natural-infrastructure.

Geosyntec Consultants and Wright Water Engineers Inc. 2009. *Urban Stormwater BMP Performance Monitoring*. Prepared under Support from US Environmental Protection Agency, Water Environment Research Foundation, Federal Highway Administration, Environmental and Water Resources Institute of the American Society of Civil Engineers. October.

Government of Western Australia. 2016. *Urban Nutrient Decision Outcomes (UNDO) Tool: User Guide, Version 1.1.0*. Water Science Technical Series, report no. 76. Department of Water.

Greenland Technologies Group Ltd. 2025. *Canadian Nutrient and Water Evaluation Tool*. https://www.grnland.com/pdf/New_GTG_Content_for_Website_Update.pdf.

Grizzetti, B., O. Vigiak, A. Udias, A. Aloe, M. Zanni, F. Bouraoui, A. Pistocchi, et al. 2021. "How EU Policies Could Reduce Nutrient Pollution in European Inland and Coastal Waters." *Global Environmental Change* 69: 102281.

Häder, D.-P., A.T. Banaszak, V.E. Villafañe, M.A. Narvarte, R.A. González, and E.W. Helbling. 2020. "Anthropogenic Pollution of Aquatic Ecosystems: Emerging Problems with Global Implications." *Science of the Total Environment* 713: 136586. https://doi.org/10.1016/j.scitotenv.2020.136586.

Harmel, R.D., P.J. Kleinman, A. Hopkins, P. Millhouser, J.A. Ippolito, and D. Sahoo. 2022. "Updates to the MANAGE Database to Facilitate Regional Analyses of Nutrient Runoff." *Agricultural and Environmental Letters* 7(2): article e20095. https://doi.org/10.1002/ael2.20095.

Huffman, R.L., D.D. Fangmeier, W.J. Elliot, and S.R. Workman. 2013. *Soil and Water Conservation Engineering*, 7th ed. St. Joseph, MO: American Society of Agricultural Engineers.

IDEM (Indiana Department of Environmental Management). 2020. *Indiana E. Coli Calculator User Guide*.

Jacobson, N., W. Larson, C. Hicks, G. Brill, and G. Moreira. 2024. *WASH Benefits Accounting Framework: A Standardized Approach for Estimating and Valuing the Multiple Benefits of Corporate Investments in Drinking Water, Sanitation and Hygiene Access: Standardized Methods Report*. LimnoTech and WASH4Work. https://ceowatermandate.org/publications/WASH-Framework.pdf.

Kadlec, R.H. 2016. "Large Constructed Wetlands for Phosphorus Control: A Review." *Water* 8: 243.

Kadlec, R.H., and R.L. Knight. 1996. *Treatment Wetlands*. Boca Raton, FL: CRC Press/Lewis.

Landphair, H.C., J.A. McFalls, and D. Thompson. 2000. *Design Methods, Selection, and Cost-Effectiveness of Stormwater Quality Structures*. Texas Department of Transportation, report 1837-1.

Lazarus, W.F., J. Tang, G. Kramer, D.J. Mulla, and D. Wall. 2014. "Watershed Nitrogen Reduction Planning Tool for Comparing the Economics of Practices to Reduce Watershed Nitrogen Loads." University of Minnesota and Minnesota Pollution Control Agency. November 21. https://wlazarus.cfans.umn.edu/activities-projects-and-interests/water-and-air-quality.

Lazarus, W.F., D.J. Mulla D. Wall, J. Galzki, and J. Tang. 2015. "Watershed Phosphorus Reduction Planning Tool (PBMP.xlsm) for Comparing the Economics of Agricultural Practices to Reduce Watershed Phosphorus Loads." September 29. University of Minnesota and Minnesota Pollution Control Agency. http://prestohost36.inmagic.com/Presto/content/Detail.aspx?ctID=NjYxYzc0ZDktODZlOC00MTA0LWFiYWEtNjk3Mjk3ZmE0Nzdl&rID=Mjg5OTk=&qrs=RmFsc2U=&q=KENhdGFsb2dfQWR2YW5jZWRfU2VhcmNoLkF1dGhvcjoobGF6YXJ1cykgT1IgQ2F0YWxvZ19BZHZhbmNlZF9TZWFyY2guRWRpdG9yOihsYXphcnVzKSBPUiBDYXRhbG9nX0FkdmFuY2VkX1NlYXJjaC5Db3Jwb3JhdGVfQXV0aG9yOihsYXphcnVzKSk=&sgn=Q2F0YWxvZ19BZHZhbmNlZF9TZWFyY2guRGF0ZV9vZl9QdWJsaWNhdGlvbj1bMjAxNTAwMDAwMDAwMDAgVE8gMjAxNTEyMzEwMDAwMDBd&qcf=NjYxYzc0ZDktODZlOC00MTA0LWFiYWEtNjk3Mjk3ZmE0Nzdl&ph=VHJ1ZQ==&bckToL=VHJ1ZQ==&rrtc=VHJ1ZQ==.

LimnoTech. 2017. "Clean Water Roadmap (CWR): Introductory Information for Public Outreach Version." http://arcgis.limno.com/CleanWaterRoadmap/docs/CWR_outreach_walkthrough.pdf.

Lin, J.P. 2004. "Review of Published Export Coefficients and Event Mean Concentration (EMC) Data." WRAP Technical Notes Collection, ERDC TN-WRAP-04-3. US Army Engineer Research and Development Center, Vicksburg, MS.

McDowell, R.W., A. Noble, P. Pletnyakov, B.E. Haggard, and L.M. Mosley. 2020. "Global Mapping of Freshwater Nutrient Enrichment and Periphyton Growth Potential." *Scientific Reports* 10: 3568.

McDowell, R.W., A. Noble, P. Pletnyakov, and L.M. Mosley. 2021. "Global Database of Diffuse Riverine Nitrogen and Phosphorus Loads and Yields." *Geoscience Data Journal* 8: 132–43.

McPhearson, T., C.M. Raymond, N. Gulsrud, et al. 2021. "Radical Changes Are Needed for Transformations to a Good Anthropocene." *npj Urban Sustainability* 1. https://doi.org/10.1038/s42949-021-00017-x.

MDEQ (Michigan Department of Environmental Quality). 1999. *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. Surface Water Quality Division.

Mitsch, W.J., and S.E. Jorgensen. 2004. *Ecological Engineering and Ecosystem Restoration*. Hoboken, NJ: John Wiley and Sons.

Montana Department of Environmental Quality. 2016. *Load Reduction Estimation Guide: A Guide for Estimating Pollutant Load Reductions Achieved through Implementation of Best Management Practices*. Prepared by Montana Department of Environmental Quality, Water Quality Planning Bureau. WQPBWPSTD-013.

OMAFRA (Ontario Ministry of Agriculture, Food, and Rural Affairs). 2023. "Universal Soil Loss Equation (USLE)." OMAFRA Fact Sheet no. 23-005.

Panagos, P., P. Borrelli, J. Poesen, C. Ballabio, E. Lugato, K. Meusburger, L. Montanarella, and C. Alewell. 2015. "The New Assessment of Soil Loss by Water Erosion in Europe." *Environmental Science and Policy* 54: 438–47.

Petersen, C., H.S. Rifai, and R. Stein. 2009. "Bacteria Load Estimator Spreadsheet Tool for Modeling Spatial *Escherichia coli* Loads to an Urban Bayou." *Journal of Environmental Engineering* 135 (4). doi:10.1061/(ASCE)0733-9372(2009)135:4(203).

Pitt, R., A. Maestre, and J. Cleary. 2018. *The National Stormwater Quality Database (NSQD), Version 4.02*.

Ranganathan, J., R. Waite, and T. Searchinger. 2020. "Regenerative Agriculture: Good for Soil Health, but Limited Potential to Mitigate Climate Change." World Resources Institute. https://www.wri.org/insights/regenerative-agriculture-good-soil-health-limited-potential-mitigate-climate-change.

Reig, P., W. Larson, S. Vionnet, and J.B. Bayart. 2019. "Volumetric Water Benefit Accounting (VWBA): A Method for Implementing and Valuing Water Stewardship Activities." Working paper. World Resources Institute. https://blueriskintel.com/volumetric-water-benefit-accounting-vwba-a-method-for-implementing-and-valuing-water-stewardship-activities/#:~:text=Volumetric%20Water%20Benefit%20Accounting%20(VWBA):%20A%20Method%20For%20Implementing%20and%20Valuing%20Water%20Stewardship%20Activities.

Reig, P., T. Shiao, K. Vigerstol, C. Copeland, A. Morgan, C. Strong, R. Hamilton, et al. 2021. *Setting Enterprise Water Targets: A Guide for Companies*. UN Global Compact CEO Water Mandate, Pacific Institute, CDP, The Nature Conservancy, World Resources Institute, and WWF. www.ceowatermandate.org/enterprise-water-targets.

RESPEC. 2017. *Documentation of the Best Management Practice Database Available in the Scenario Application Manager*. Draft Topical Report RSI-2742. Prepared by Seth Kenner and Jared Oswald for the Minnesota Pollution Control Agency.

Robertson, D.M., and D.A. Saad. 2019. *Spatially Referenced Models of Streamflow and Nitrogen, Phosphorus, and Suspended-Sediment Loads in Streams of the Midwestern United States*. US Geological Survey Scientific Investigations Report 2019–5114. https://doi.org/10.3133/sir20195114.

Robertson, D.M., D.A. Saad, and G.E. Schwarz. 2014. "Spatial Variability in Nutrient Transport by HUC8, State, and Subbasin Based on Mississippi/Atchafalaya River Basin SPARROW Models." *Journal of the American Water Resources Association* 50(4): 988–1009.

Saad, D.A., G.E. Schwarz, D.M. Argue, D.W. Anning, S.W. Ator, A.B. Hoos, S.D. Preston, et al. 2019. *Estimates of Long-Term Mean Daily Streamflow and Annual Nutrient and Suspended-Sediment Loads Considered for Use in Regional SPARROW Models of the Conterminous United States, 2012 Base Year*. US Geological Survey Scientific Investigations Report 2019–5069. https://doi.org/10.3133/sir20195069.

SBTN (Science Based Targets Network). 2024. "Step 3 Freshwater: Measure, Set & Disclose (Version 1.1)."

Schueler, T.R. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs.* Washington, DC: Metropolitan Washington Council of Governments.

Smullen, J., and K. Cave. 1998. "Updating the Nationwide Urban Runoff Quality Database." Paper presented at Third International Conference on Diffuse Pollution, August 31–September 4, Scottish Environment Protection Agency, Edinburgh.

Stack, B., L. Fraley-McNeal, J. Fox, and R. Christianson. 2018. *Finding and Adding Agricultural BMP Performance Studies to the Agricultural BMP Database*. WRF project no. STAR-N6R14/4857.

Stein, E.D., L.L. Tiefenthaler, and K.C. Schiff. 2008. "Comparison of Stormwater Pollutant Loading by Land Use Type." Southern California Coastal Water Research Project, AR08-015-027.

Stewart, B.A., D.A. Woolhiser, W.H. Wischmeier, J.H. Caro, and M.H. Frere. 1975. *Control of Water Pollution from Cropland*. Volume 1, *A Manual for Guideline Development*. EPA~0012-75-026a. Washington, DC: US Environmental Protection Agency.

Stuntebeck, T.D., M.J. Komiskey, D.W. Owens, and D.W. Hall. 2008. *Methods of Data Collection, Sample Processing, and Data Analysis for Edge-of-Field, Streamgaging, Subsurface-Tile, and Meteorological Stations at Discovery Farms and Pioneer Farm in Wisconsin, 2001–7*. US Geological Survey Open-File Report 2008–1015.

Tetra Tech. 2022. *User's Guide: Pollutant Load Estimation Tool (PLET) Version 1.0*. Developed for US Environmental Protection Agency. March.

Texas A&M AgriLife. 2022. *Agricultural Policy/Environmental Extender Model.* October 13. https://epicapex.tamu.edu/apex/.

UN (United Nations). n.d. "Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All." Sustainable Development Goals. Accessed April 29, 2025. https://sdgs.un.org/goals/goal6#targets_and_indicators.

UNEP (UN Environment Programme). 2016. *A Snapshot of the World's Water Quality: Towards a Global Assessment.* https://www.wwqa-documentation.info/download-reports.html.

UN Global Compact CEO Water Mandate, Pacific Institute, CDP, The Nature Conservancy, World Resources Institute, WWF, and UNEPDHI Partnership Centre for Water and Environment. 2019. "Setting Site Water Targets Informed by Catchment Context: A Guide for Companies." www.ceowatermandate.org/site-water-targets.

USDA ARS (US Department of Agriculture, Agricultural Research Service). 2002. *User's Guide: Revised Universal Soil Loss Equation Version 2*.

USDA ARS. 2013. *Scientific Documentation: Revised Universal Soil Loss Equation Version 2 (RUSLE2) (for the Model with Release Date of May 20, 2008)*.

US EPA (US Environmental Protection Agency). 1985. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water, Part 1*. EPA/600/6-85/002a. September.

US EPA. 2012. "Water: Contaminated Sediments." https://archive.epa.gov/water/archive/polwaste/web/html/contaminants.html.

US EPA. 2013. "Water Quality Criteria [Collections and Lists]." https://www.epa.gov/wqc.

US EPA. 2016. "Phosphorus TMDLs for Vermont Segments of Lake Champlain. US EPA Region 1." June 17.

US EPA. 2018. *Nutrient and Sediment Estimation Tools for Watershed Protection*. EPA 841-K-18-002. March 3. https://www.epa.gov/sites/default/files/2018-08/documents/loadreductionmodels2018.pdf.

US EPA. 2020. *Corporate GHG Inventorying and Target Setting Self-Assessment: V1.0*. April.

US EPA. 2025. "Designated Uses." https://www.epa.gov/wqs-tech/designated-uses.

USGS (US Geological Survey). 2018. "Water Science School: Temperature and Water." https://www.usgs.gov/special-topics/water-science-school/science/temperature-and-water#overview.

VDEQ (Virginia Department of Environmental Quality). 2024. *Virginia Runoff Reduction Method, Version 4.1: Compliance Spreadsheet User's Guide and Documentation*. July.

WBCSD (World Business Council for Sustainable Development). 2017. "Social Capital Protocol." https://docs.wbcsd.org/2017/03/Forest_Sector_Guide.pdf.

WBCSD. 2019. "Social and Human Capital Protocol." https://www.wbcsd.org/Archive/Assess-and-Manage-Performance/Social-Human-Capital-Protocol.

Weiss, P.T., J.S. Gulliver, and A.J. Erickson. 2005. *The Cost and Effectiveness of Stormwater Management Practices*. Minnesota Department of Transportation, Research Services Section, MN/RC 2005-23.

White, M., D. Harmel, H. Yen, J., M. Gambone, and R. Haney. 2015. "Development of Sediment and Nutrient Export Coefficients for U.S. Ecoregions." *Journal of the American Water Resources Association* 51 (3): 758–75.

Williams, M.R., K.W. King, W. Ford, and N.R. Fausey. 2016. "Edge-of-Field Research to Quantify the Impacts of Agricultural Practices on Water Quality in Ohio." *Journal of Soil and Water Conservation* 71 (1): 9A–12A.

Wischmeier, W.H., and D.D. Smith. 1965. *Predicting Rainfall-Erosion Losses from Cropland East of the Rocky Mountains: Guide for Selection of Practices for Soil and Water Conservation*. Agricultural Handbook No. 282. Washington, DC: USDA Agricultural Research Service, Soil and Water Conservation Research Division.

Wohl, E., B. Bledsoe, R. Jacobson, N. Poff, S. Rathburn, D. Walters, and A. Wilcox. 2015. "The Natural Sediment Regime in Rivers: Broadening the Foundation for Ecosystem Management." *BioScience* 65(4): 358–71. https://doi.org/10.1093/biosci/biv002.

World Resources Institute, LimnoTech, The Nature Conservancy. 2025. "Volumetric Water Benefit Accounting 2.0: Guidance for implementing, evaluating, and claiming volumetric water benefits of water stewardship projects." Guidebook. Washington, DC: World Resources Institute. Available online at: https://doi.org/10.46830/wrigb.23.00112.

WWF (World Wildlife Fund) and GlobeScan. 2025. *The Future Water Agenda: How Water Can Lead the Way for Sustainability and Collective Action*. https://globescan.com/2025/03/19/the-future-water-agenda-report/.

Xu, H., Y. Jia, Z. Sun, J. Su, Q.S. Liu, Q. Zhou, and G. Jiang. 2022. "Environmental Pollution, a Hidden Culprit for Health Issues." *Eco-Environment and Health* 1 (1): 31–45. https://doi.org/10.1016/j.eehl.2022.04.003.

Zeckoski, R.W., B.L. Benham, S.B. Shah, M.L. Wolfe, K.M. Brannan, M. Al-Smadi, T.A. Dillaha, et al. 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management." *Applied Engineering in Agriculture* 21 (5): 879–89.

Acknowledgments

We are pleased to acknowledge our institutional strategic partners that provide core funding to WRI: the Netherlands Ministry of Foreign Affairs, Royal Danish Ministry of Foreign Affairs, and Swedish International Development Cooperation Agency.

This publication was made possible thanks to financial support provided by AB InBev, Amazon Web Services, Cargill, The Coca-Cola Company, Google, Meta, and Starbucks. Special thanks to former WRI colleagues, Nanda Aung and Caroline Black, for their contributions to this guidebook.

The authors would like to thank the following for their extensive guidance and feedback during the design and development of this method:

Experts representing the corporate sponsors:

- AB InBev: Alex Mung
- Amazon Web Services: Marlies Michielssen and Will Hewes
- Cargill: Truke Smoor, Lina Gkountakou, and Colin Strong
- The Coca-Cola Company: Madhu Rajesh and Jan Burger
- Google: Tara Varghese and Anna Escuer
- Meta: Stefanie Woodward
- Starbucks: Christina Babbitt

Experts consulted:

- Paul Reig, Bluerisk
- Jenna Stewart, Bluerisk
- Todd Reeve, Bonneville Environmental Foundation
- Marta Ceadel, Danone
- Fátima Bertrán De Lis, denkstatt
- Ivan Paspaldzhiev, denkstatt
- Michael Alexander, Diageo
- Clare Keating, Earth Genome
- Emilio Tenuta, Ecolab
- Ed Pinero, Ecometrics, LLC
- Margot Conover, General Mills International
- Dave Dilks, LimnoTech
- Ian Knight, Mars Inc.
- Eliza Roberts, Microsoft
- Michael Lagua, National Fish and Wildlife Foundation
- Michaël Clément, Nestlé Waters
- Michael Nemeth, Nutrien
- Gregg Brill, Pacific Institute/CEO Water Mandate
- Mary Beth Cote-Jenssen, PepsiCo
- David Grant, PepsiCo
- Andrea Fasano, Pfizer
- Tatiana Fedotova, Quantis
- Ariane Lardo, Quantis
- Hannah Birge, The Nature Conservancy
- Craig Holland, The Nature Conservancy
- Matt Rea, The Nature Conservancy
- Valerie Strassberg, The Nature Conservancy
- Justin Ehrenwerth, The Water Institute of the Gulf
- Will Brownlie, UK Centre for Ecology and Hydrology
- Jeff King, US Army Corps of Engineers
- Mindy Selman, US Department of Agriculture
- Yongping Yuan, US Environmental Protection Agency
- Todd Gartner, World Resources Institute
- Nicole Tanner, World Wildlife Fund

Reviewers:

- Marissa Streyle, Alliance for Water Stewardship
- Klaudia Schachstschneid, Pacific Institute
- Kyle McKay, US Army Corps of Engineers
- Emily Neagle, World Resources Institute
- Apoorva R, World Resources Institute
- Katie Reytar, World Resources Institute
- Katharina Wache, World Resources Institute
- Tinnebeb Yohannes, World Resources Institute
- Gyan de Silva, World Wildlife Fund
- Alexis Morgan, World Wildlife Fund

About the authors

Authors are listed alphabetically and by organization affiliation.

World Resources Institute

Sara Walker, Corporate Water Engagement Director, World Resources Institute, sara.walker@wri.org

LimnoTech

Derek Schlea, Principal and Senior Ecological Engineer, LimnoTech, dschlea@limno.com

Steve Skripnik, Principal and Senior Environmental Engineer, LimnoTech, sskripnik@limno.com

Laura Weintraub, Vice President and Senior Water Resources and Environmental Engineer, LimnoTech, lweintraub@limno.com

The Nature Conservancy

Naabia Ofosu-Amaah, Senior Corporate Engagement Advisor, Water and Resilience, The Nature Conservancy, n.ofosu-amaah@tnc.org

Kari Vigerstol, Director of Water Security Science, The Nature Conservancy, kvigerstol@tnc.org

Photo Credits

Cover, European Space Agency; Pg. 2, Sara Walker; Pg. 4, Aleš Krivec; Pg. 7, Richard Johnson; Pg. 9, Tana Kappel; Pg. 10, Billy Johnson/LimnoTech; Pg. 14, Nate Jacobson/LimnoTech; Pg. 17, Carlos Eduardo Joos; Pg. 18, Diana Teran/LimnoTech; Pg. 22, Waterkeeper Alliance Inc.; Pg. 27, Chesapeake Bay Program; Pg. 29, Chesapeake Bay Program; Pg. 30, LimnoTech; Pg. 32, LimnoTech; Pg. 35, Sunny; Pg. 37, Charlotte Kinzie; Pg. 38, Aaron Minnick/World Resources Institute

About WRI

World Resources Institute works to improve people's lives, protect and restore nature, and stabilize the climate. As an independent research organization, we leverage our data, expertise, and global reach to influence policy and catalyze change across systems like food, land and water; energy; and cities. Our 2,000+ staff work on the ground in more than a dozen focus countries and with partners in over 50 nations.

About LimnoTech

LimnoTech, established in 1975, is an employee-owned water science and environmental engineering firm. We have a passion for clean, sustainable water and work alongside our clients and partners who share our vision for building thriving ecosystems and better places to live. LimnoTech's science-based body of work and contributions as thought leaders, including codeveloping Volumetric Water Benefit Accounting (VWBA) and VWBA 2.0, WASH Benefit Accounting, and Water Quality Benefit Accounting (WQBA) allow us to help guide corporations through every step of a water stewardship journey. We support our clients with basin diagnostics, water risk assessments and mapping, development of water stewardship strategies, goals and targets, project scoping, decision support tool development, water benefit accounting (VWBA and VWBA 2.0, WQBA, WASH), tracking and reporting, Alliance for Water Stewardship Standard implementation, and CDP water disclosure. The foundation of our work is the common goal of helping to ensure availability and access to clean water for all, protect ecosystems, promote public health, support economic stability, adapt to climate impacts, and foster social equity.

About The Nature Conservancy

The Nature Conservancy is a global environmental nonprofit working to create a world where people and nature can thrive. Founded in the United States through grassroots action in 1951, The Nature Conservancy (TNC) has grown to become one of the most effective and wide-reaching environmental organizations in the world. Thanks to more than a million members and the dedicated efforts of our diverse staff and over 400 scientists, we impact conservation in 77 countries and territories: 41 by direct conservation impact and 36 through partners.

WORLD RESOURCES INSTITUTE

10 G Street, NE
Washington, DC 20002
WRI.org